

Earth Observation in support of Global Urban Monitoring the SAR4Urban project

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Earth Observation Center (EOC)

German Remote Sensing Data Center (DFD)

Land Surface (LAX)



innovators
sarforurban



Knowledge for Tomorrow



Motivation

- At DLR we generated the **Global Urban Footprint (GUF)**, a **mask of built-up areas** derived from TerraSAR-X and TanDEM-X data acquired between 2011 and 2013;



12m spatial resolution

www.dlr.de/guf



Motivation

- At DLR we generated the **Global Urban Footprint (GUF)**, a **mask of built-up areas** derived from TerraSAR-X and TanDEM-X data acquired between 2011 and 2013;
- SAR data proved extremely effective for mapping urban areas.
- ESA SAR data are available:
 - from 1991 to 2012 (**ERS-1/2**, **ASAR**);
 - from 2014 onwards (**S1A**, **S1B**, S1C, S1D, ...).



SAR4Urban

- **Objective:** mapping past and current urbanization by means of ESA radar imagery.
- SAR4Urban is one of the 12 ESA DUE Innovators III projects;
- **Project Manager:** Dr.-Ing. Mattia Marconcini (DLR)
- **Technical Officer:** Marc Paganini (ESA)
- **Budget:** 200K;
- **Duration:** April 2015 – March 2017;
- **Users:**



The World Bank Group (contact point: **Nancy Lozano** - Social, Urban, Rural and Resilience);



GEO Global Urban Observation and Information Task for Societal Benefits (GEO SB-04) – contact point: **Prof. Qihao Weng**

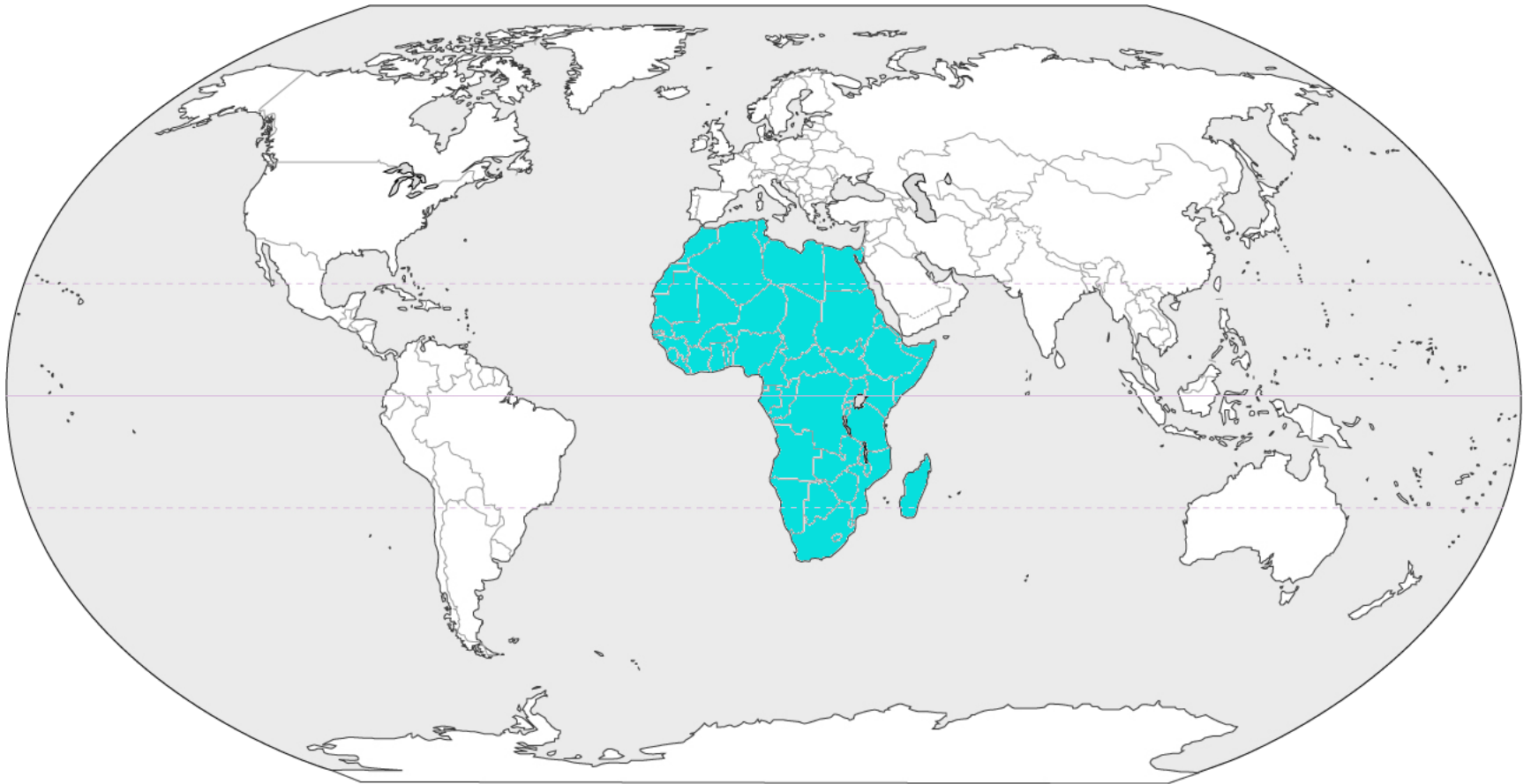


Areas and Periods of Interest



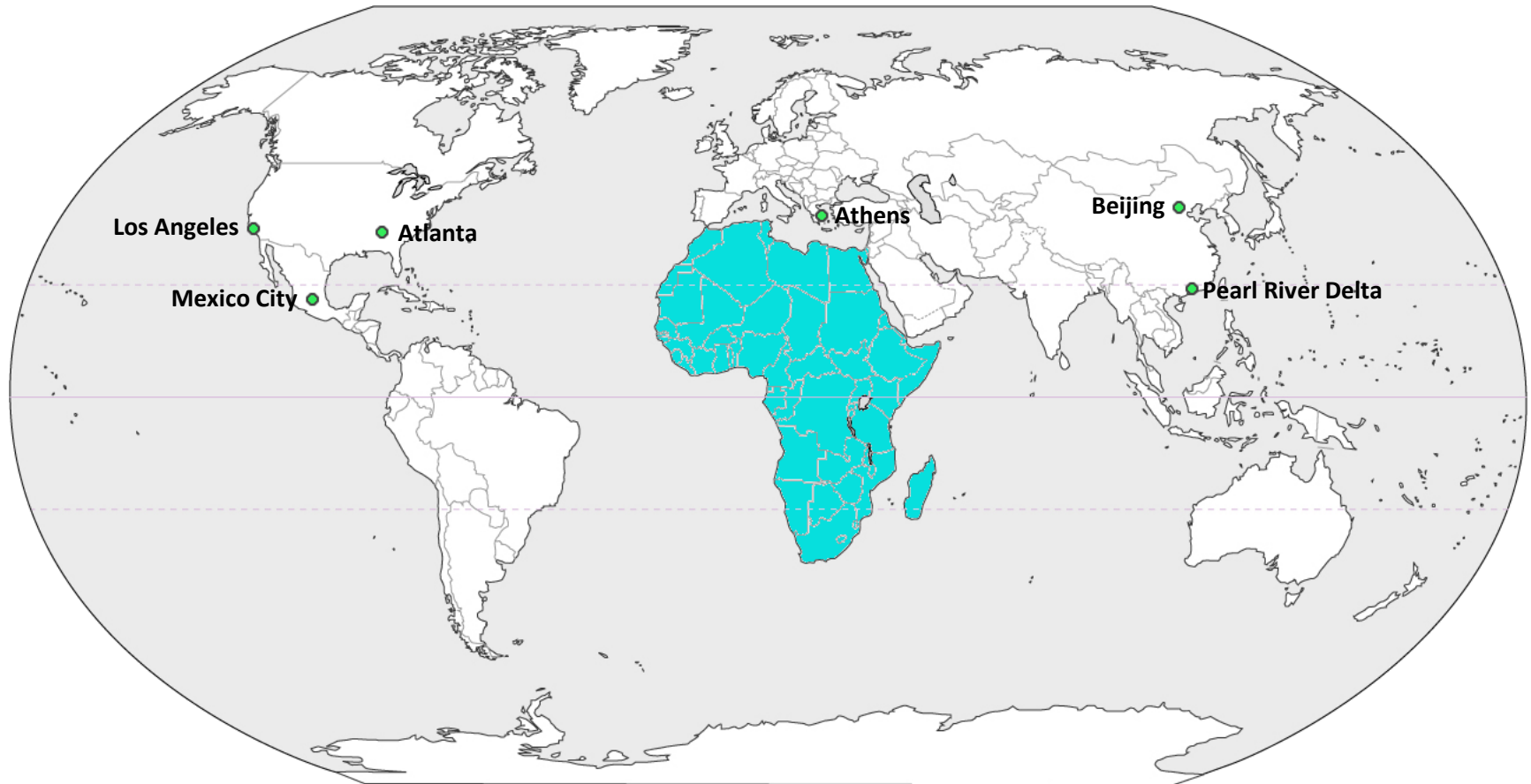
Areas and Periods of Interest

 **ASAR WSM 2002-2003**
~75m spatial resolution

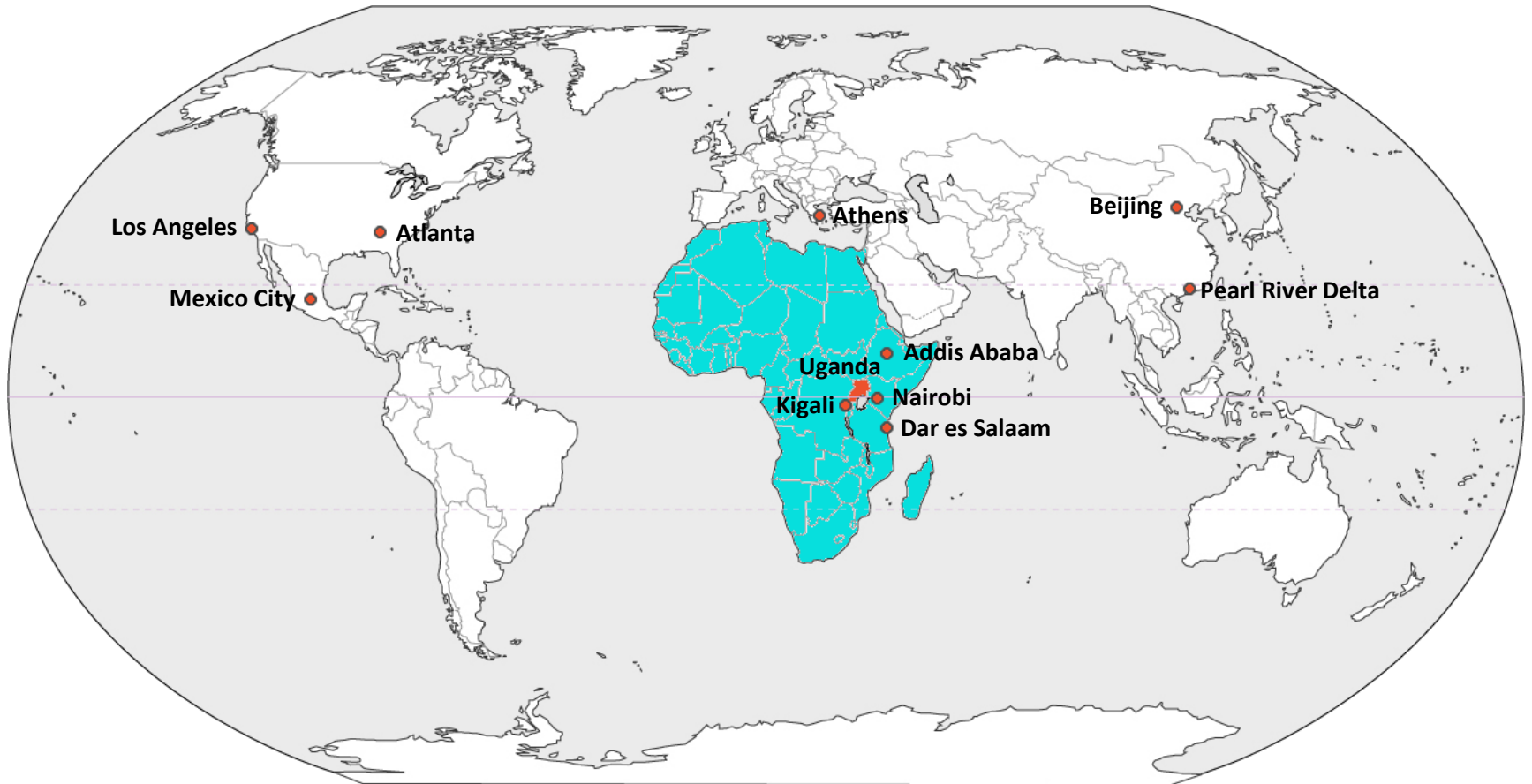


Areas and Periods of Interest

 **ASAR WSM 2002-2003**  **ERS-1/2 PRI & ASAR IMP 2002-2003**
~75m spatial resolution ~15m spatial resolution



Areas and Periods of Interest



Rationale

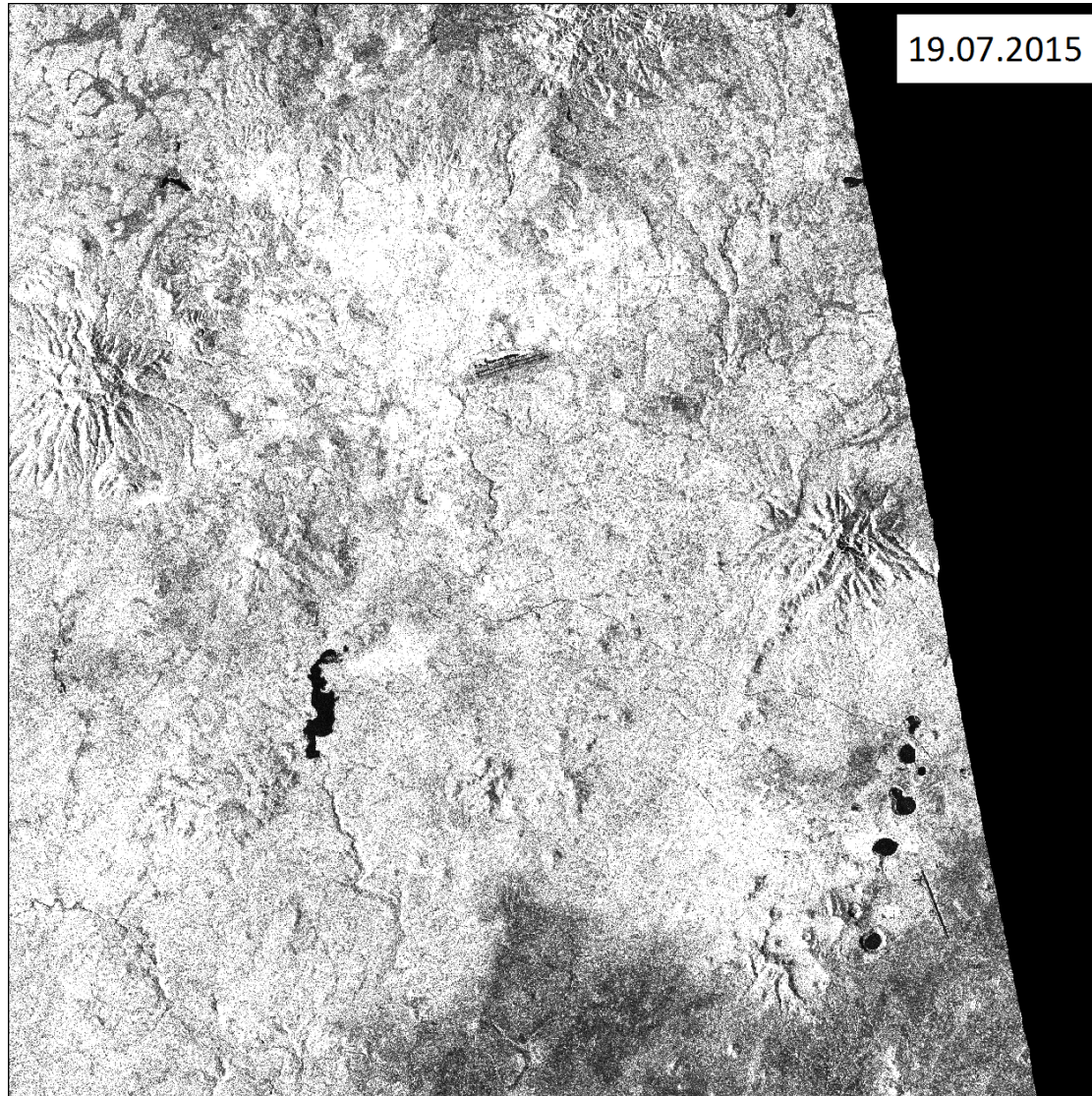
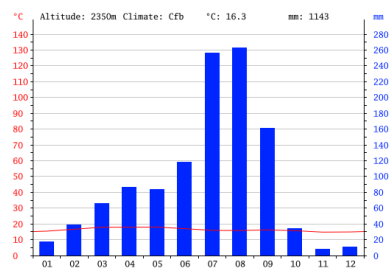
Given a series of multi-temporal SAR images for a given study area, the **temporal dynamics of urban settlements are sensibly different than those of all other non-urban classes.**

- urban areas** → always **high backscattering**
- complex topography areas → high backscattering (can be masked by properly analyzing the DEM)
- other non-urban areas → lower backscattering (high only under specific conditions)



Implemented Methodology

precipitation



S1A IW GRDH
VV
multitemporal
series

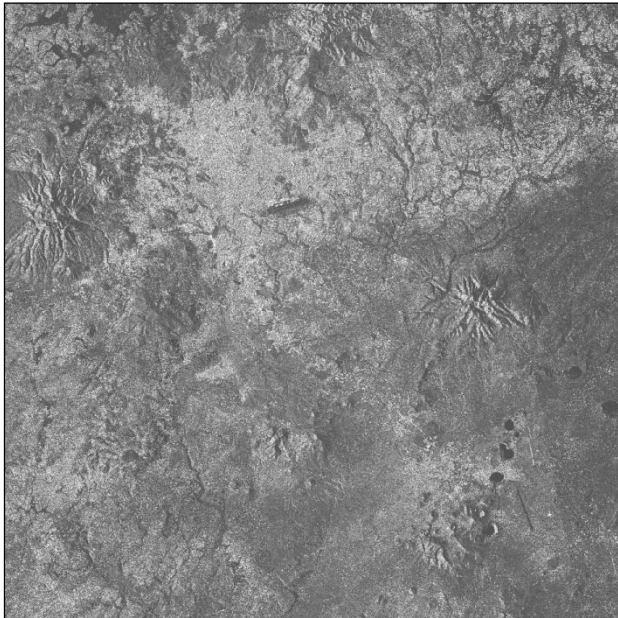
-
20 scenes
ascending pass

-
10m spatial
resolution

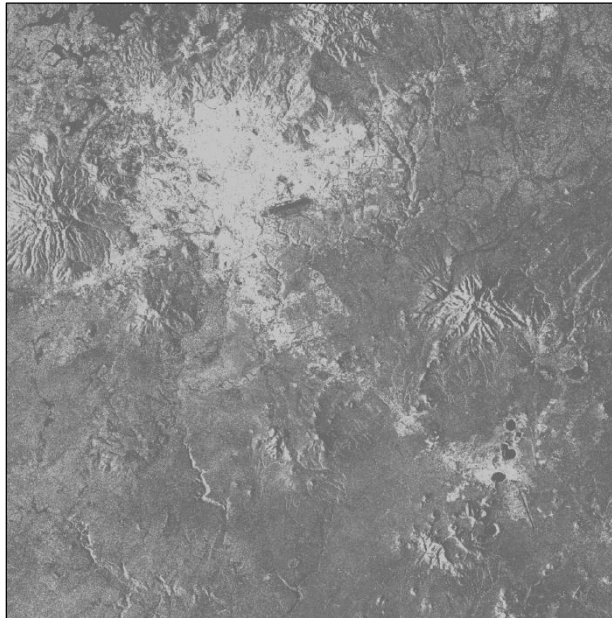


Implemented Methodology

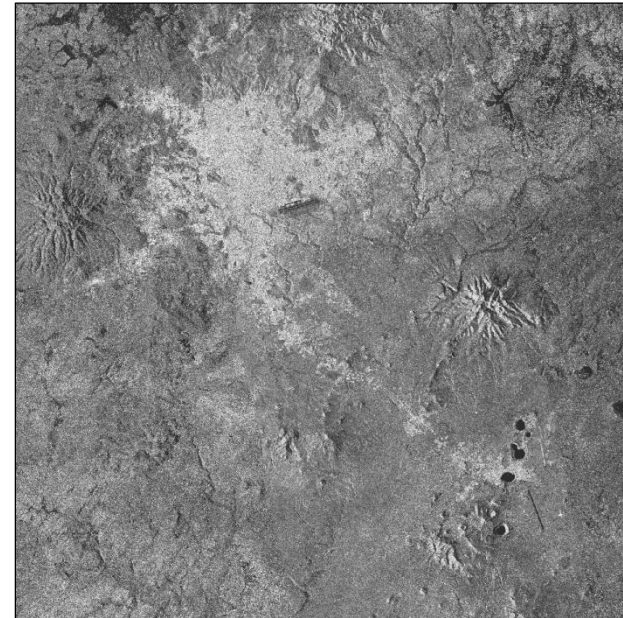
Idea: **extract multi-temporal indices** “compressing” all the available information.



temporal σ^0 mean slope



temporal σ^0 mean

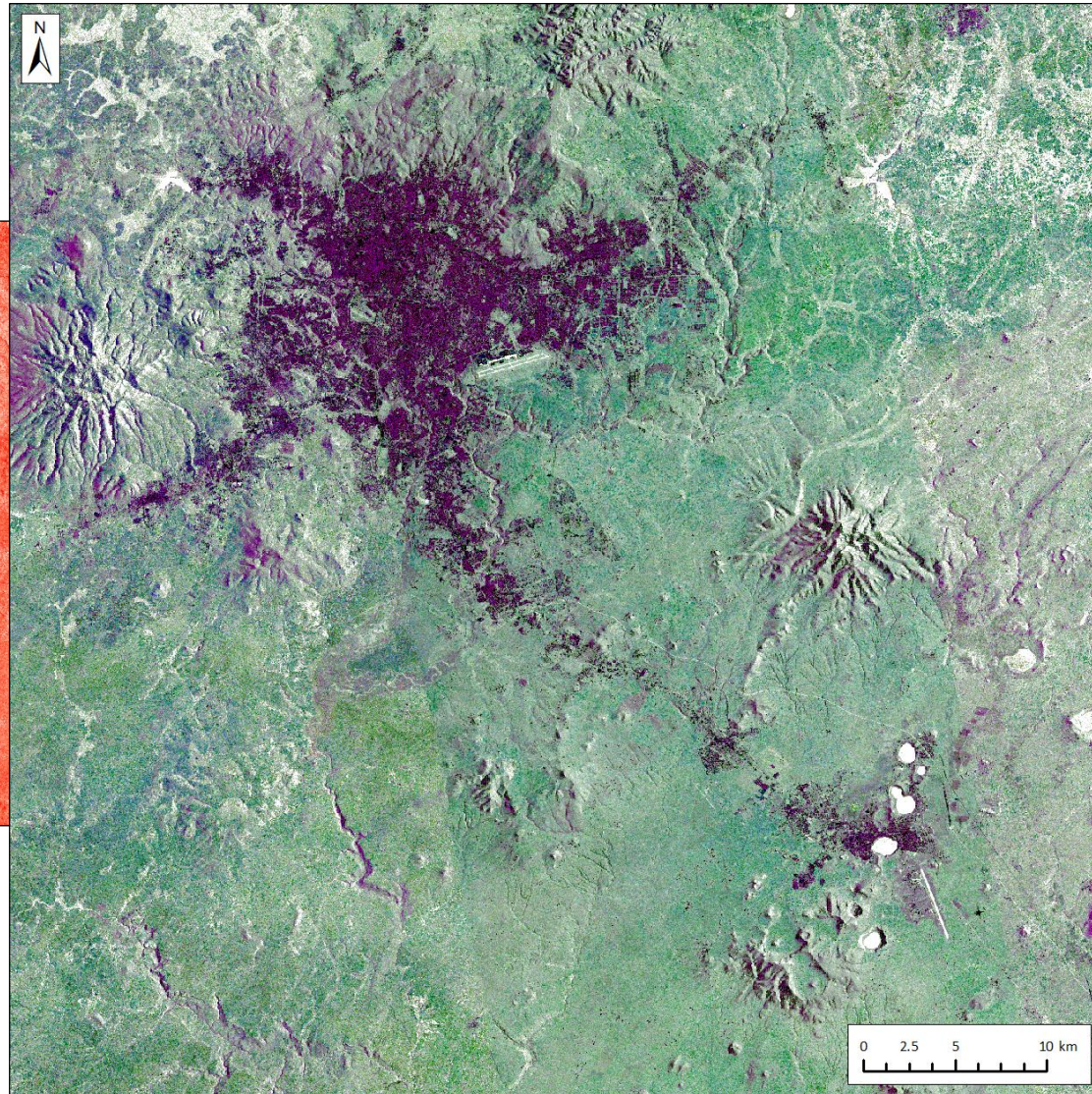


temporal σ^0 standard deviation



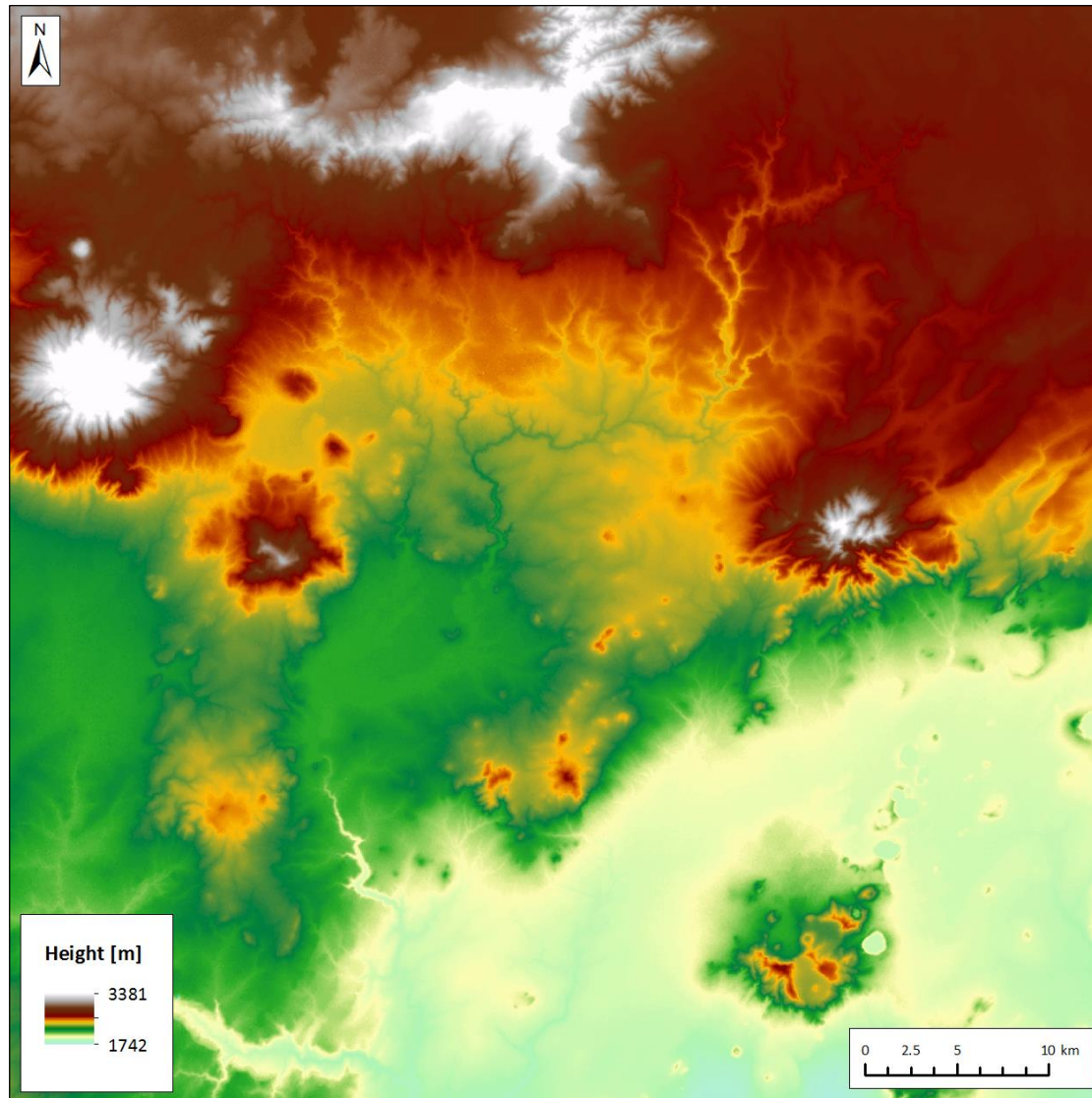
Implemented Methodology

 Addis Ababa



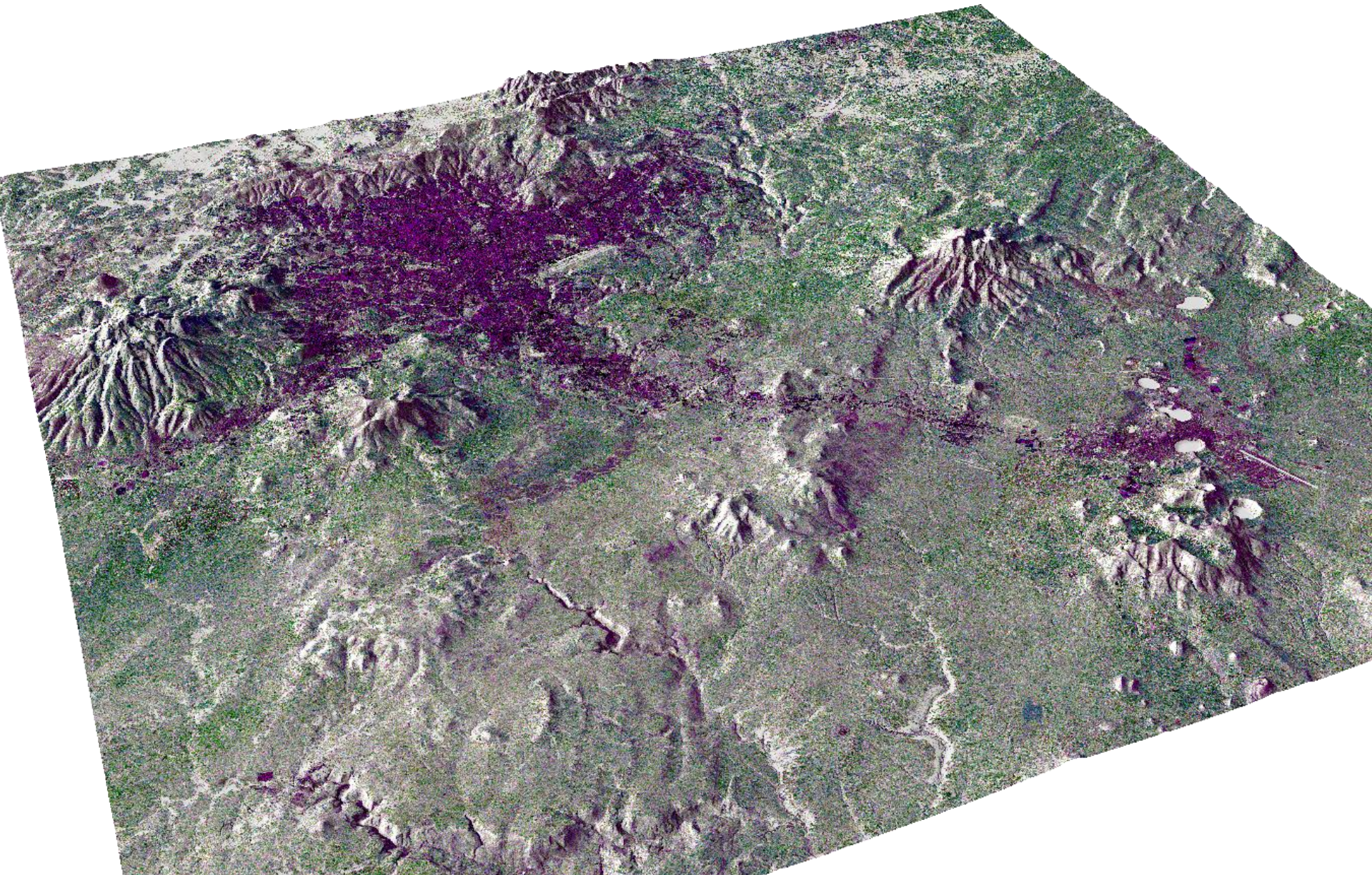
Implemented Methodology

 Addis Ababa



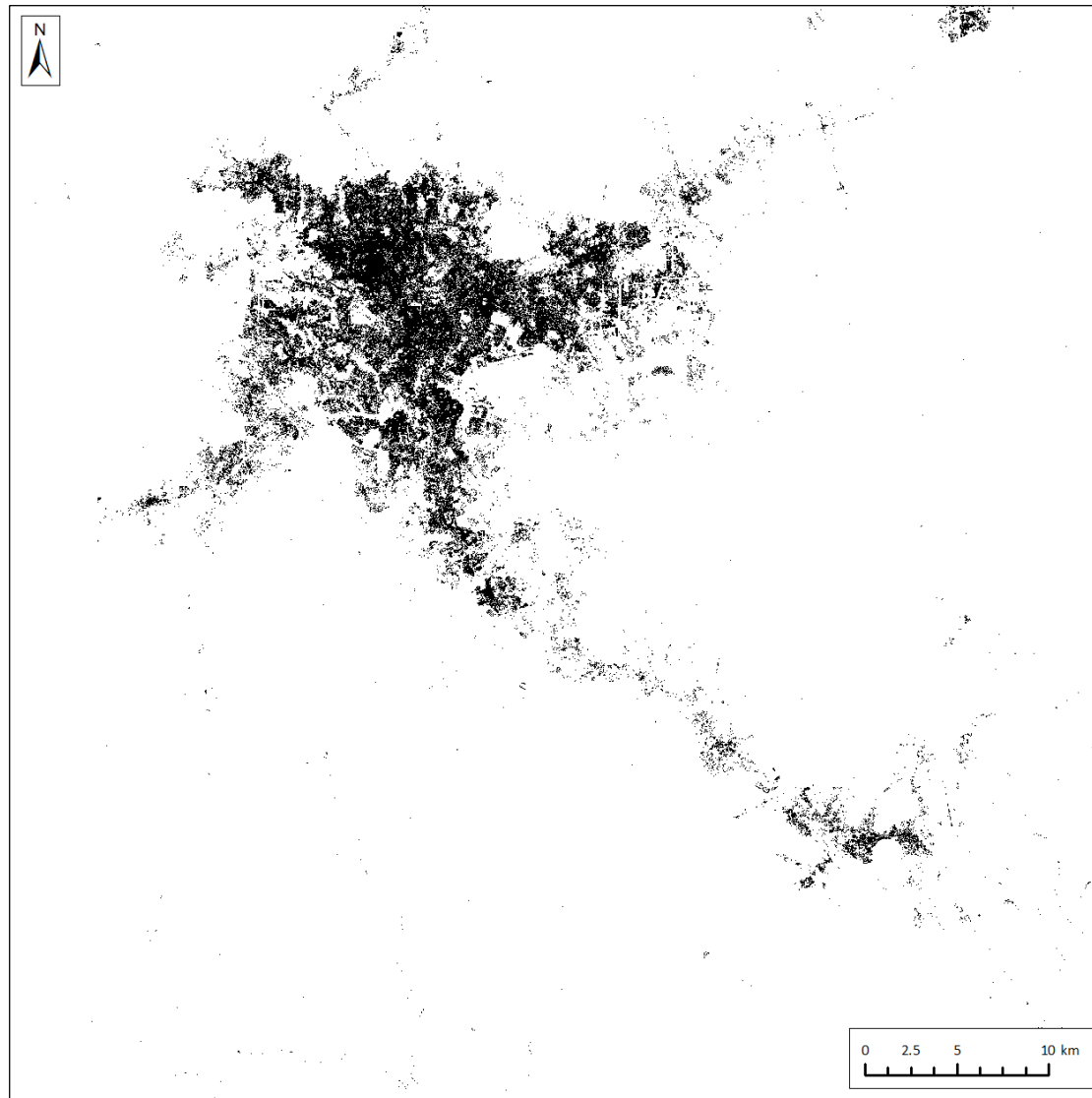
High-Resolution
SRTM 1 arcsec
(~30 m)

Implemented Methodology



Implemented Methodology

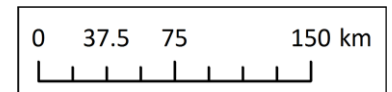
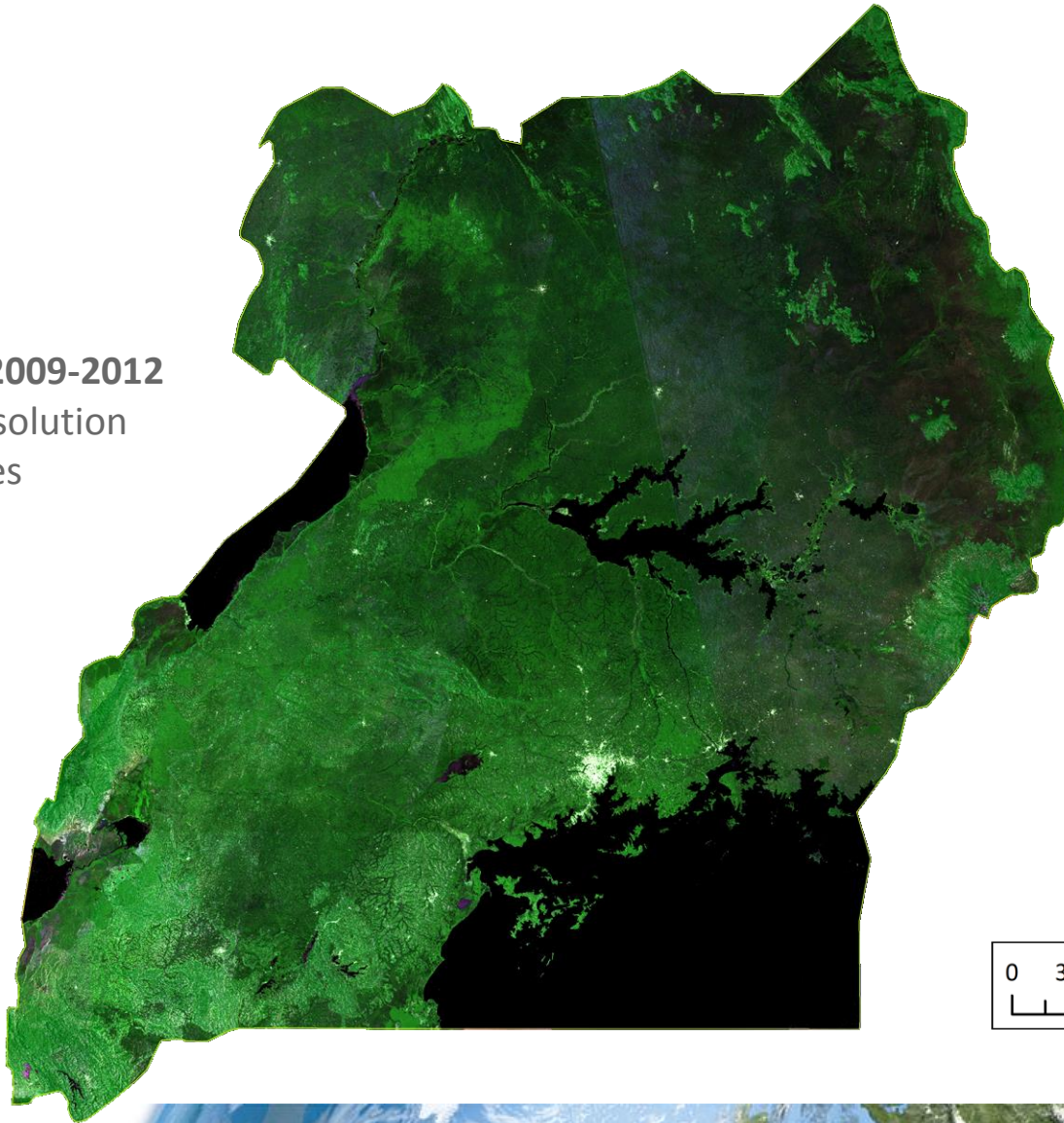
 Addis Ababa



Envisat ASAR WSM



ASAR WSM HH 2009-2012
75m spatial resolution
71 scenes

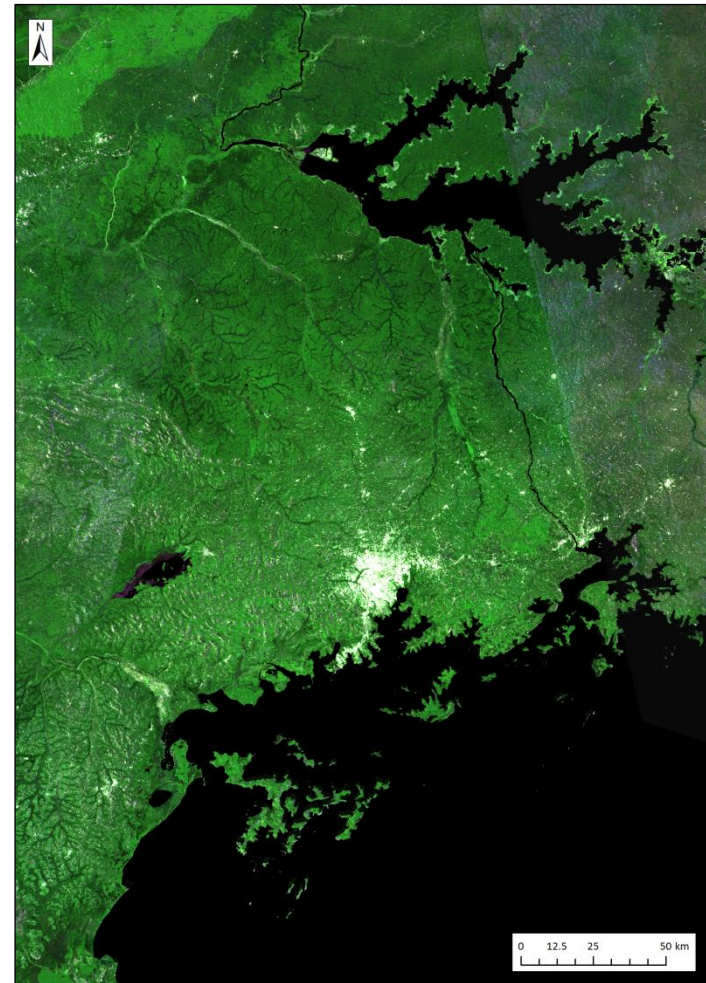


Envisat ASAR WSM

ASAR WSM HH 2002-2003

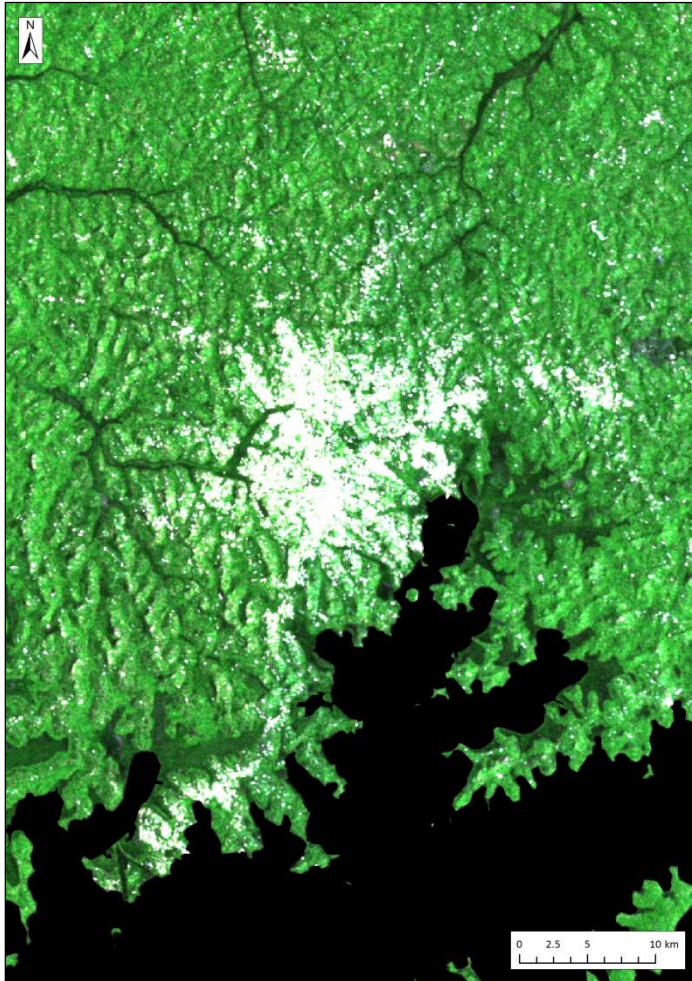


ASAR WSM HH 2009-2012

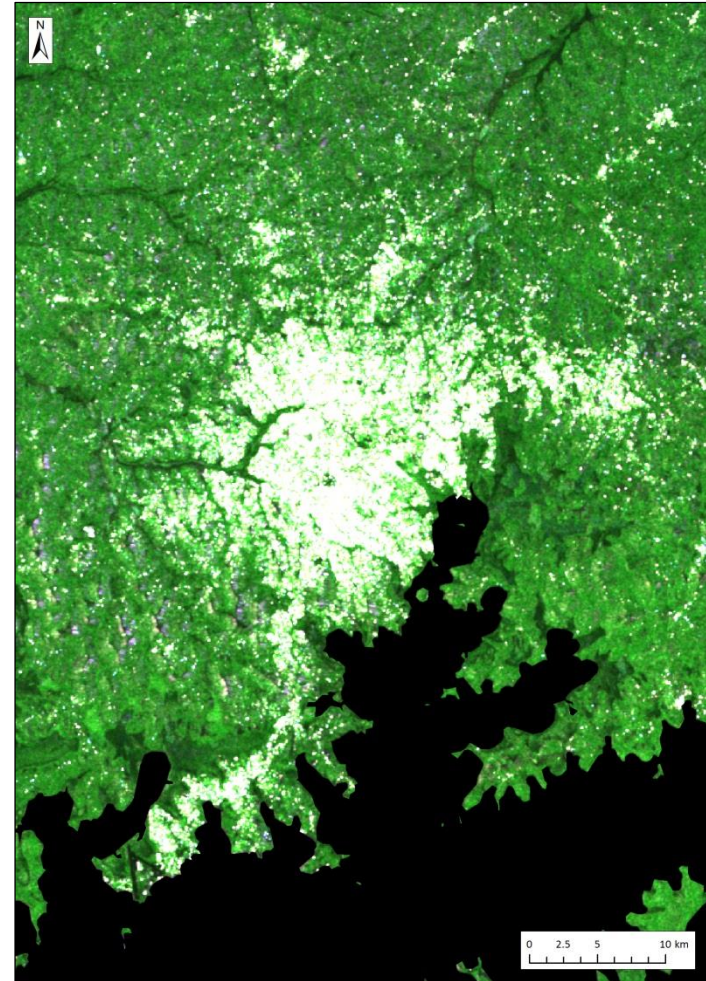


Envisat ASAR WSM

ASAR WSM HH 2002-2003



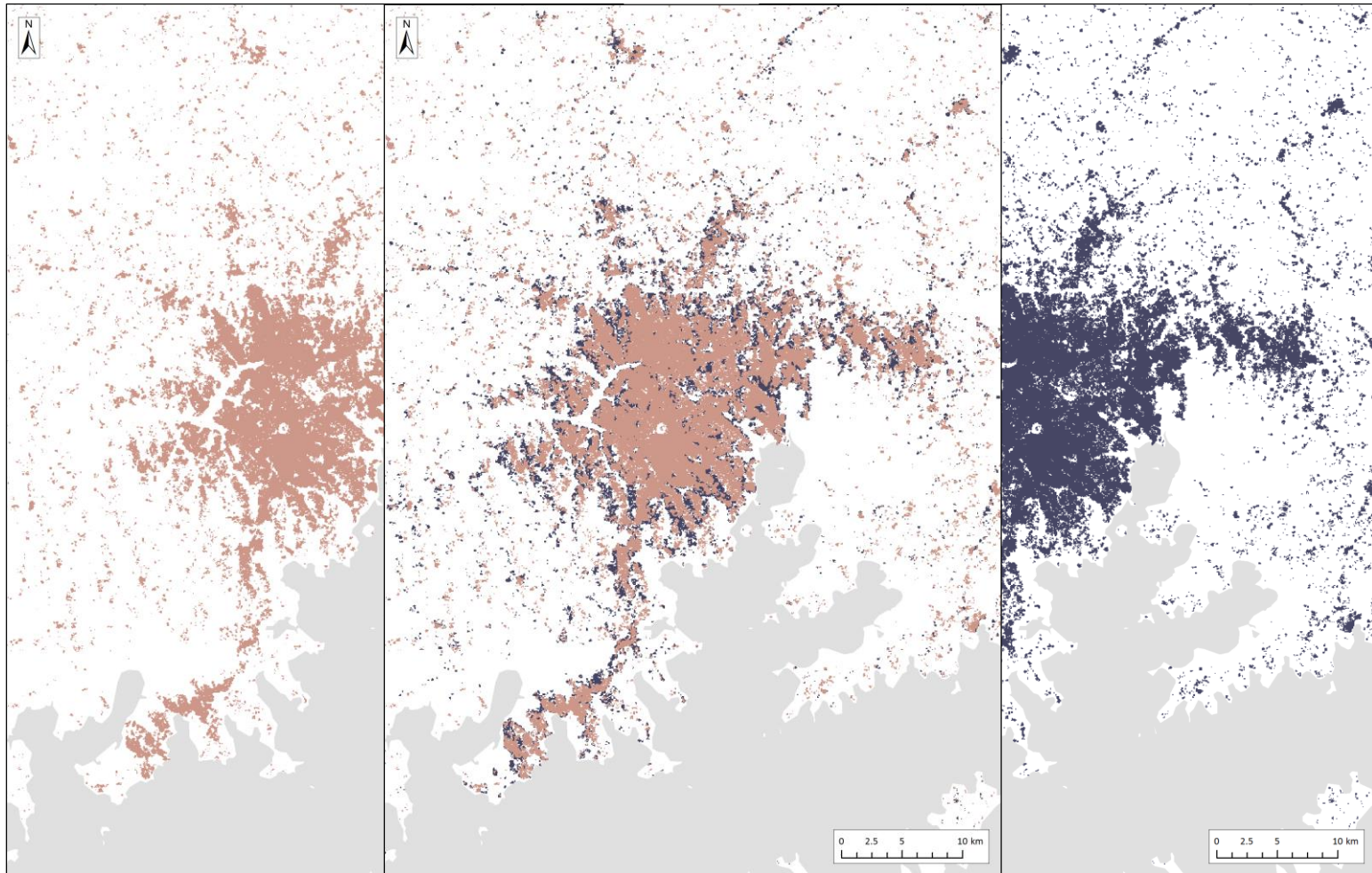
ASAR WSM HH 2009-2012



Envisat ASAR WSM

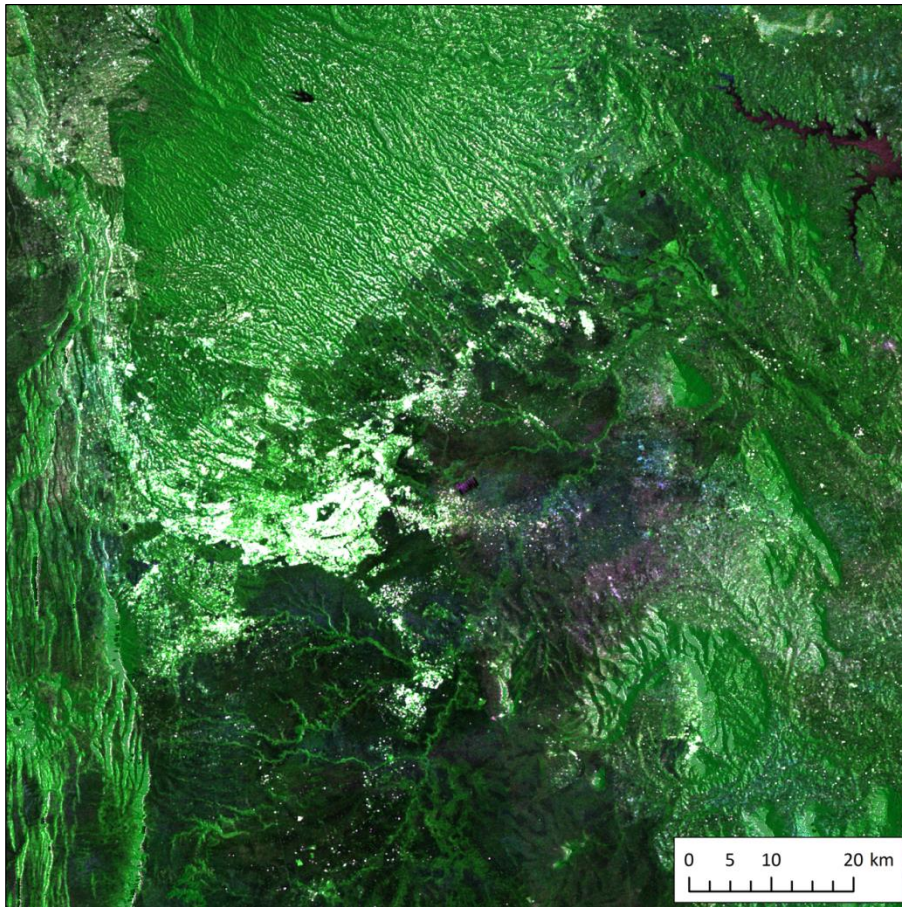
2002-2003

2009-2012

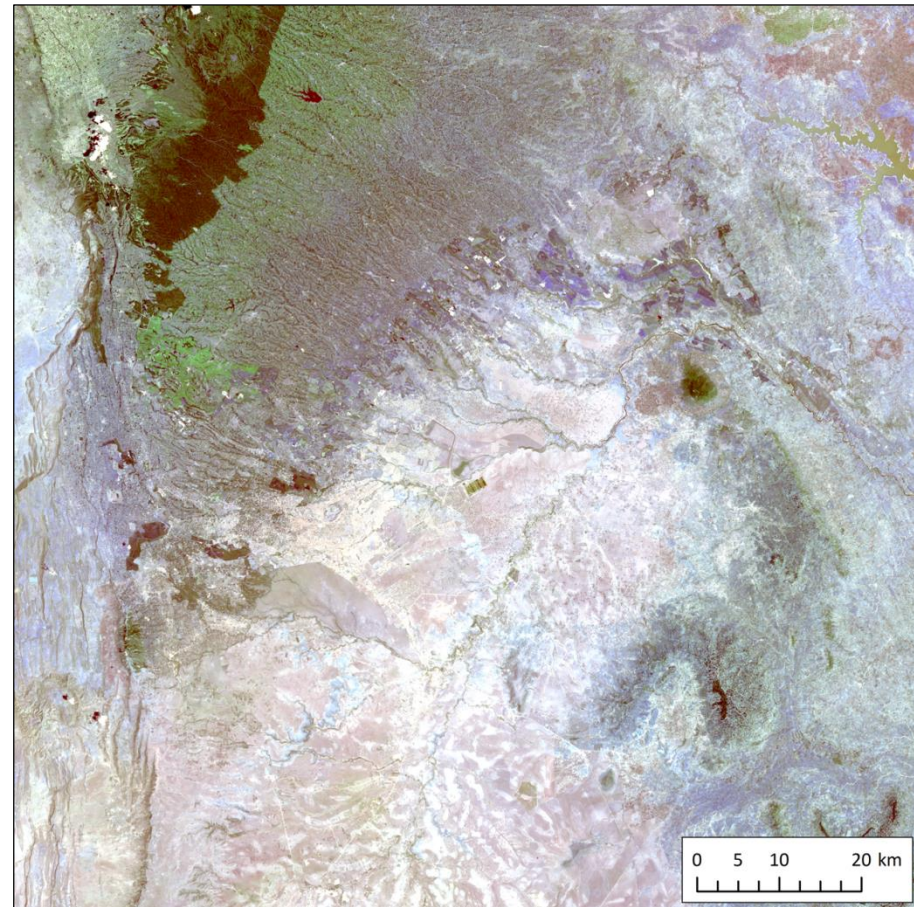


Envisat ASAR WSM

 Nairobi



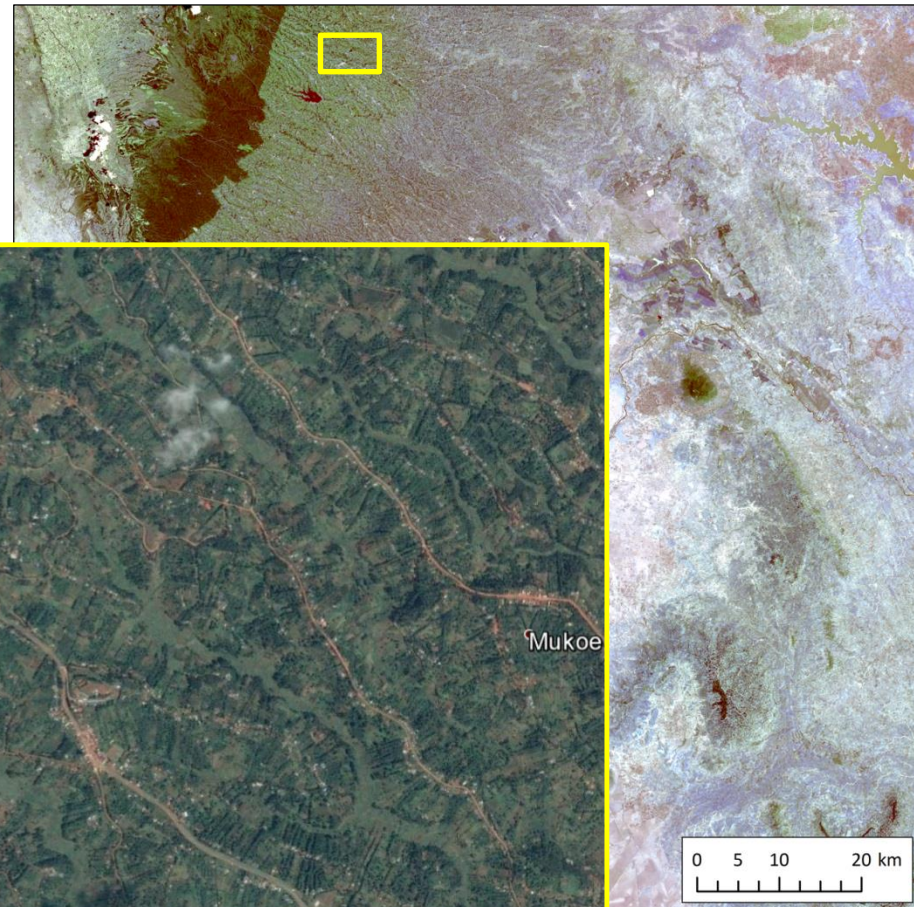
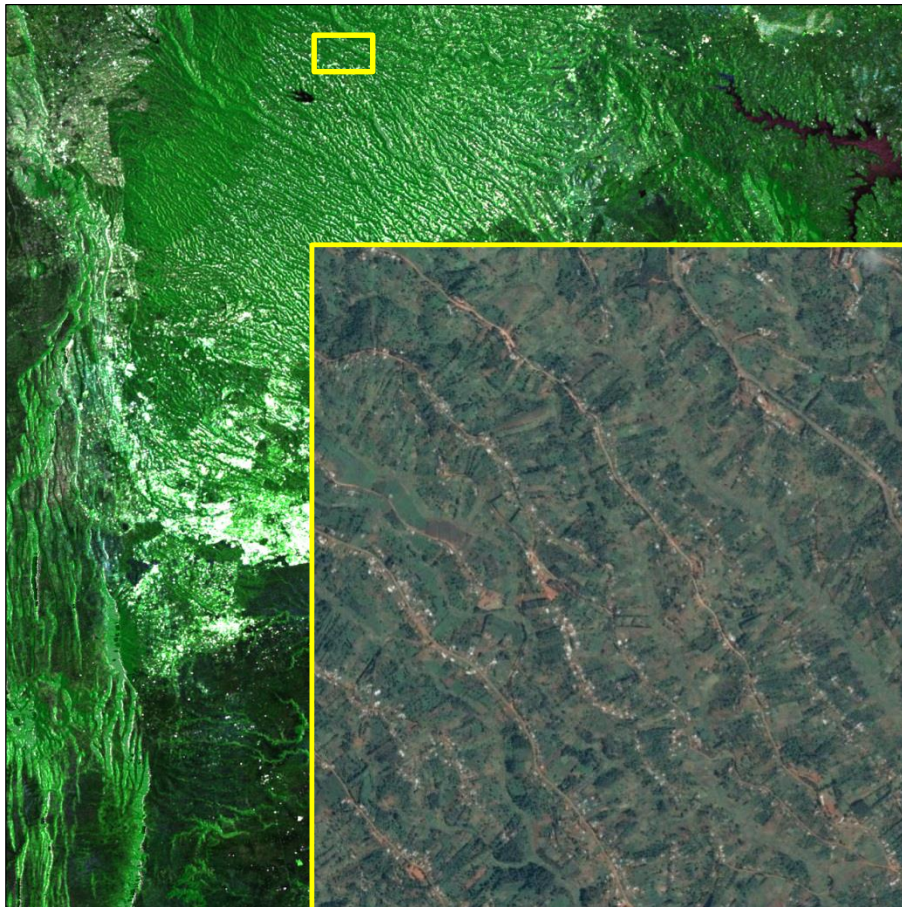
ASAR WSM HH 2009-2012



Landsat-8 OLI 2014



Envisat ASAR WSM



ASAR

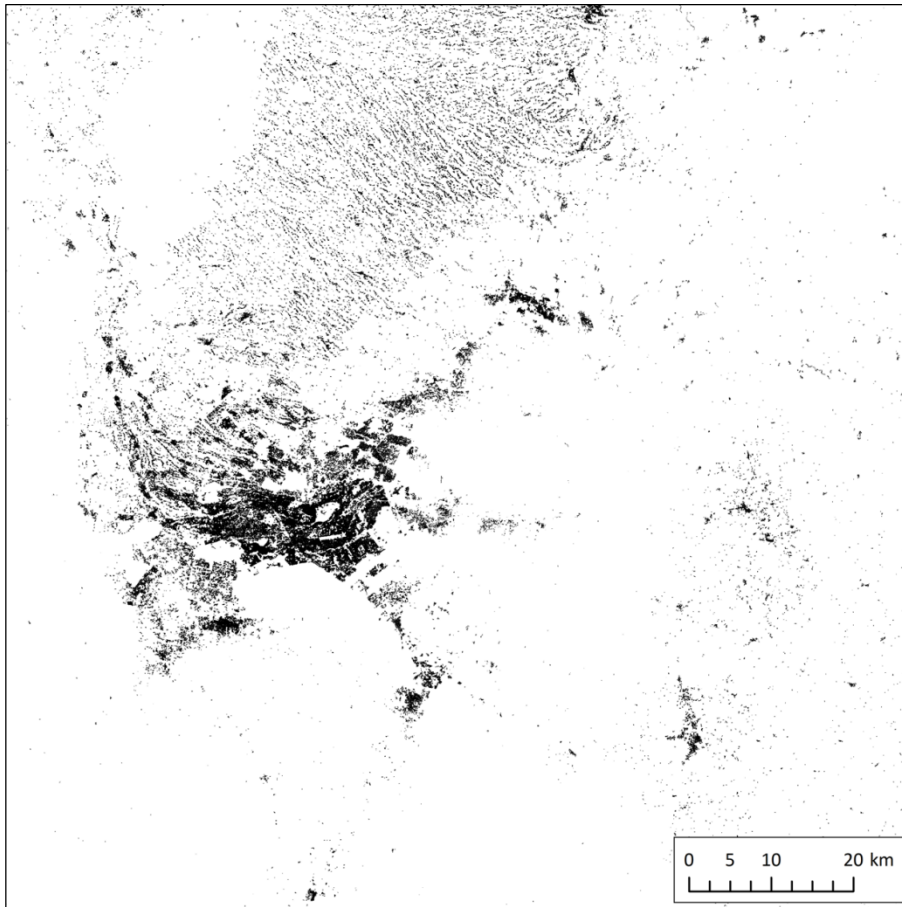
Google earth
Image © 2015 DLR / Airbus
© 2015 Google

4

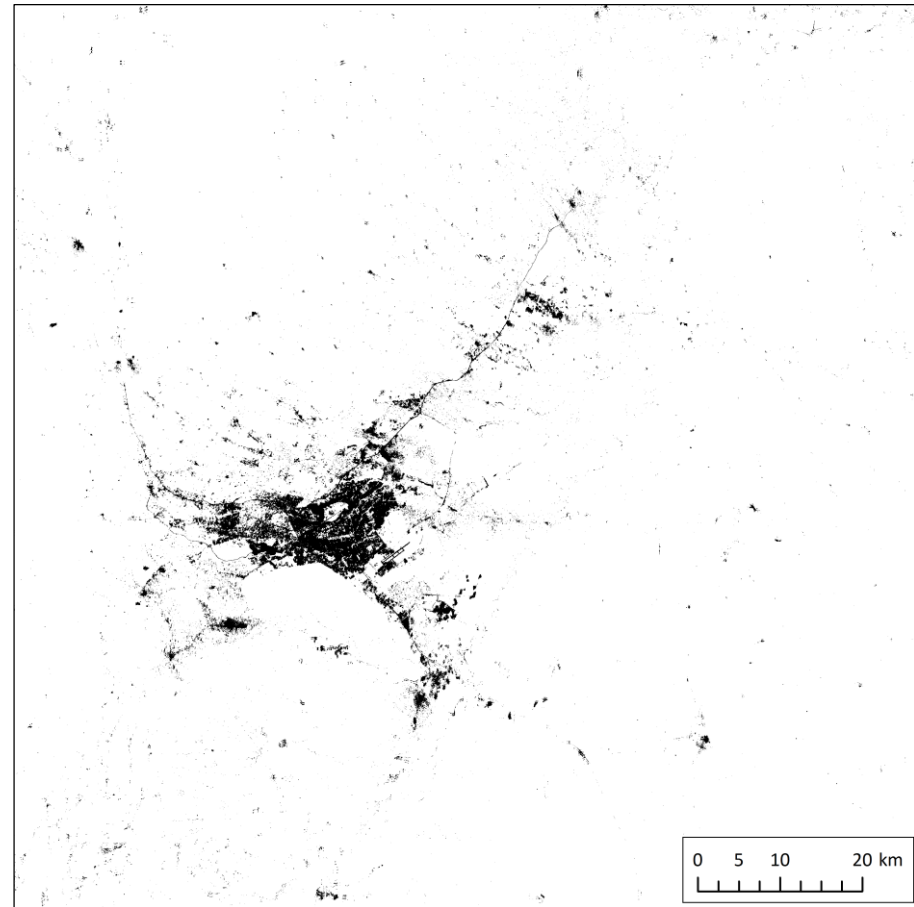


Envisat ASAR WSM

 Nairobi



ASAR WSM HH 2009-2012

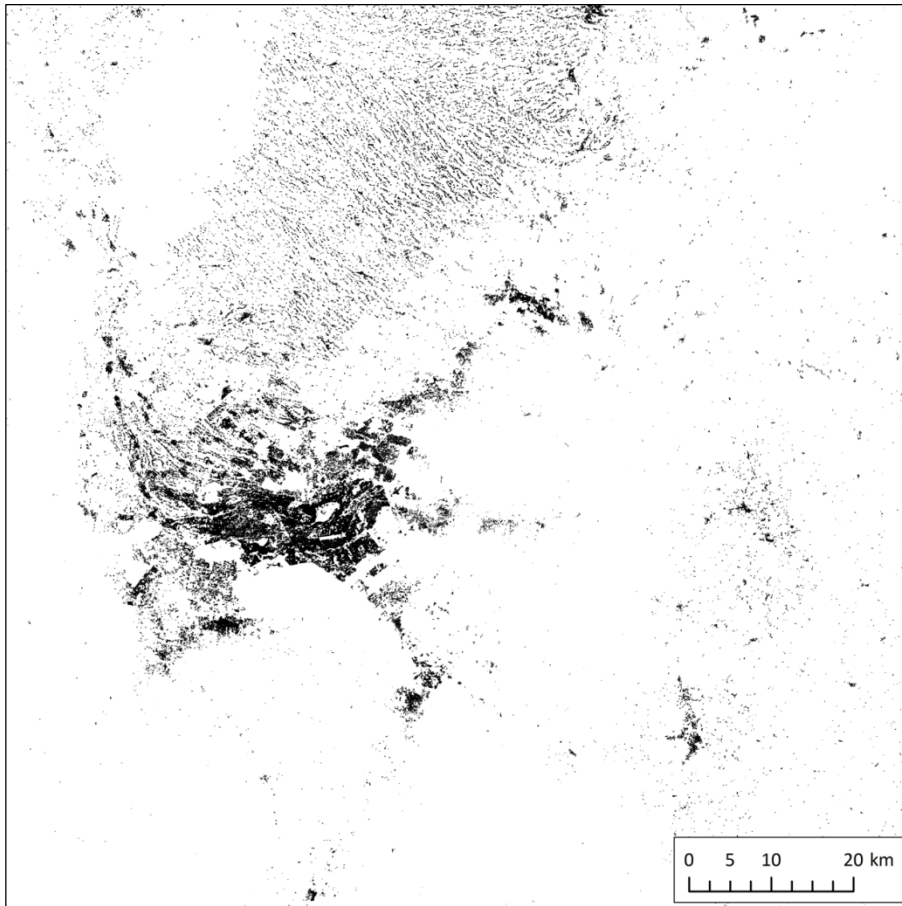


Landsat-8 OLI 2014

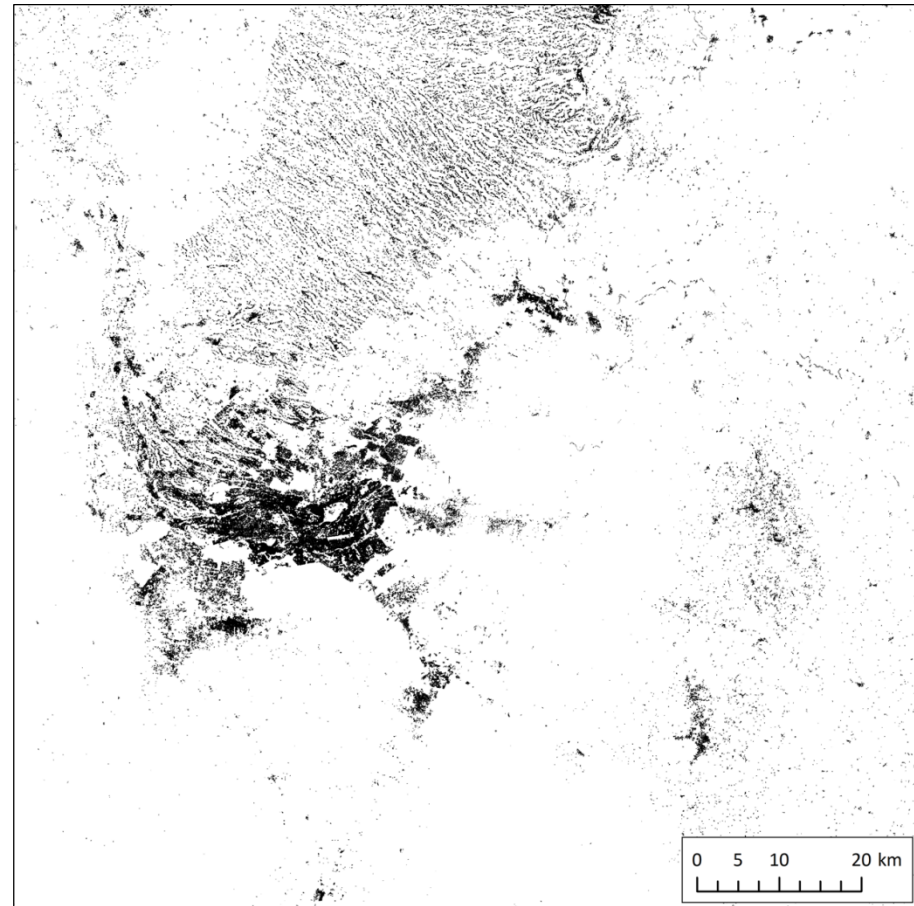


Envisat ASAR WSM

 Nairobi



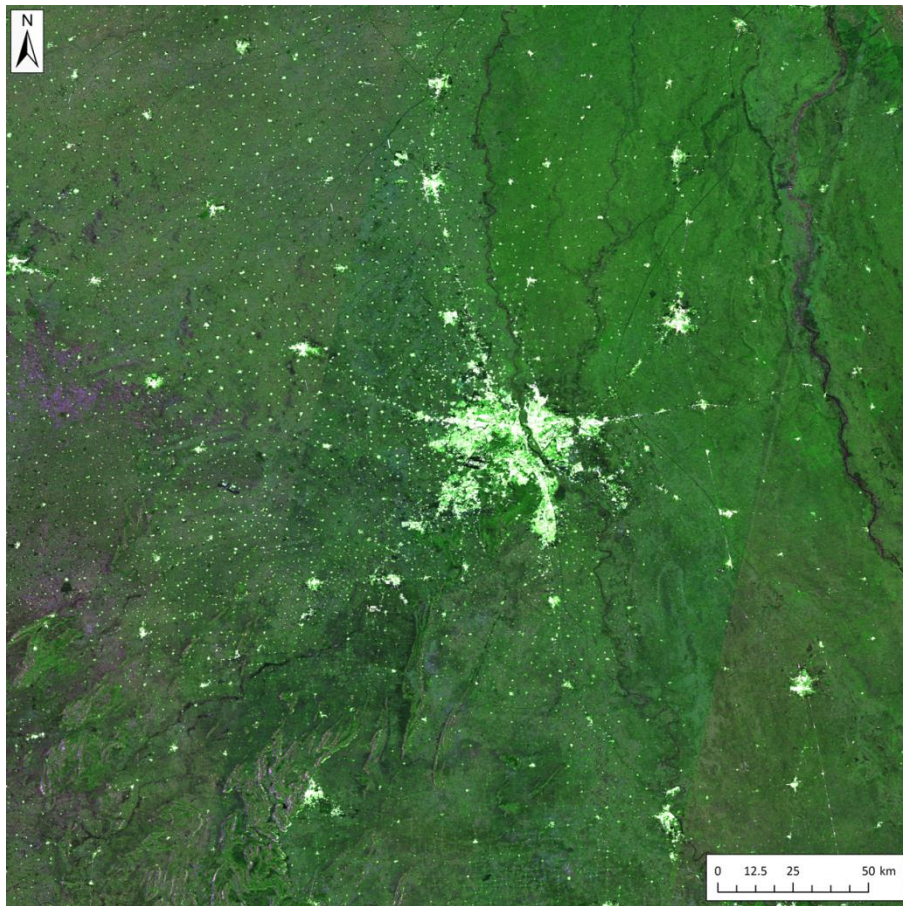
ASAR WSM HH 2009-2012



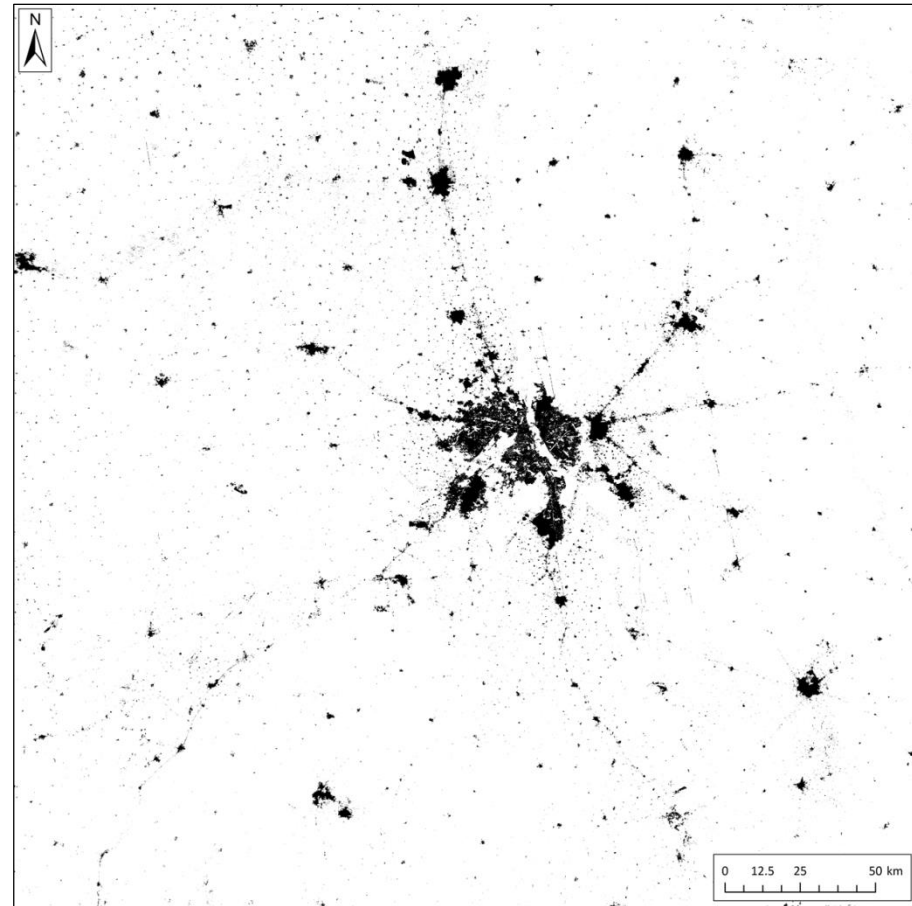
GOF



Envisat ASAR WSM



ASAR WSM VV 2009-2012

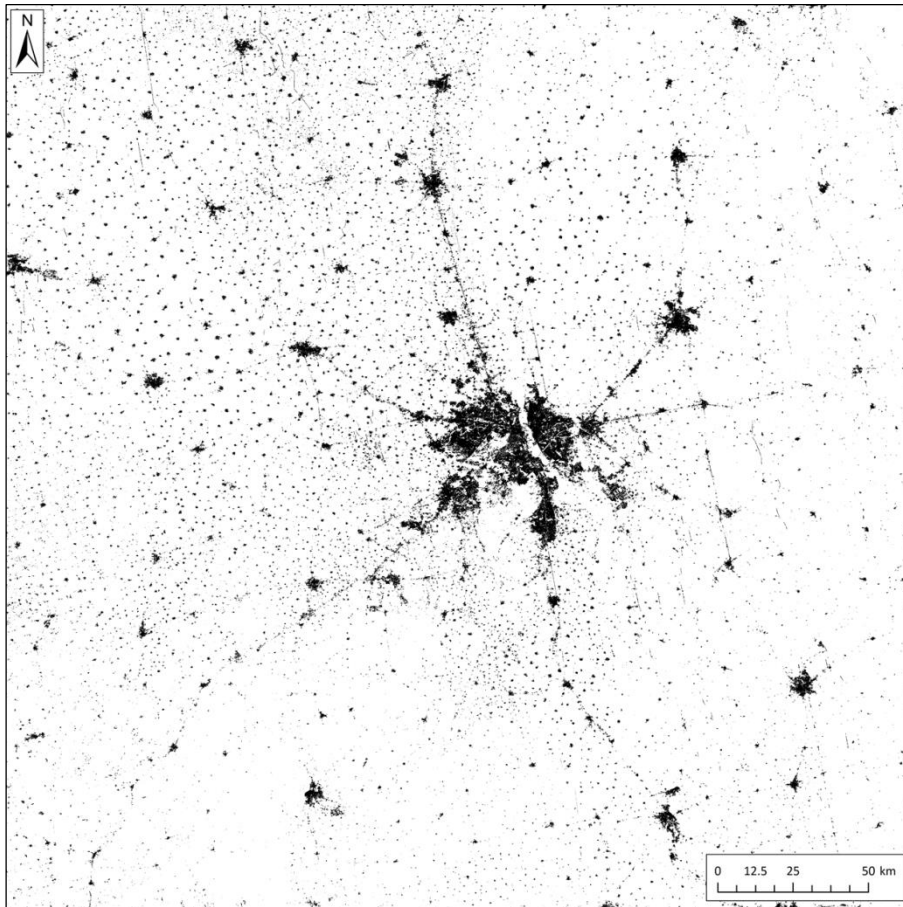


Landsat-8 OLI 2014

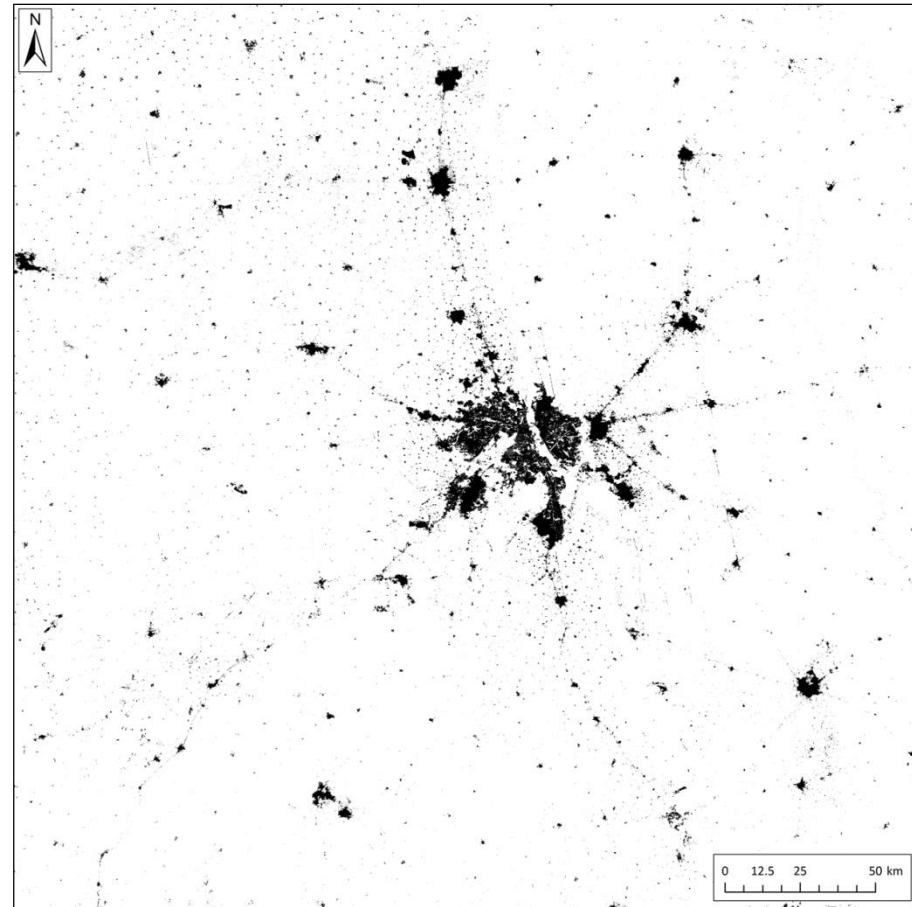


Envisat ASAR WSM

 New Delhi



ASAR WSM VV 2009-2012



Landsat-8 OLI 2014

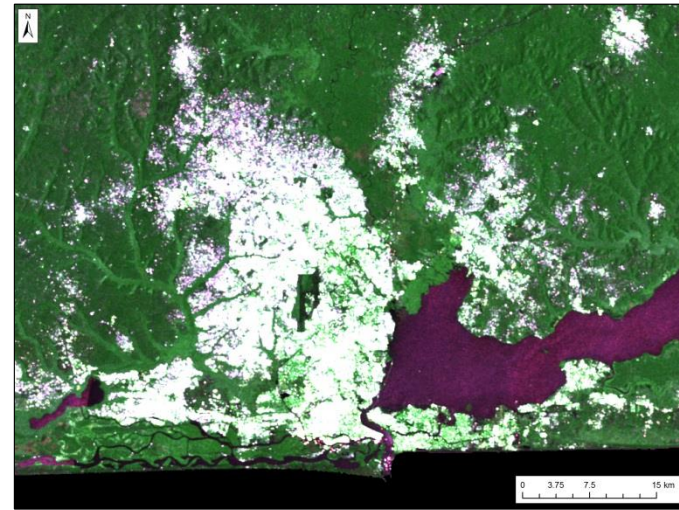
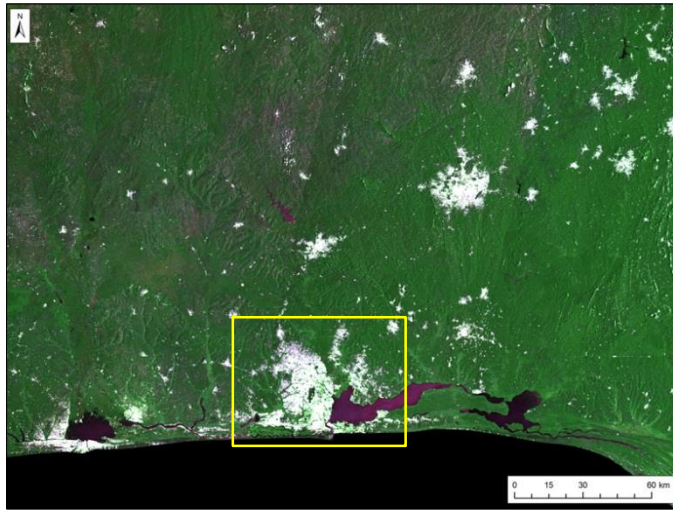


Envisat ASAR WSM

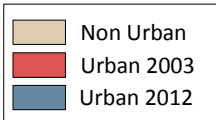
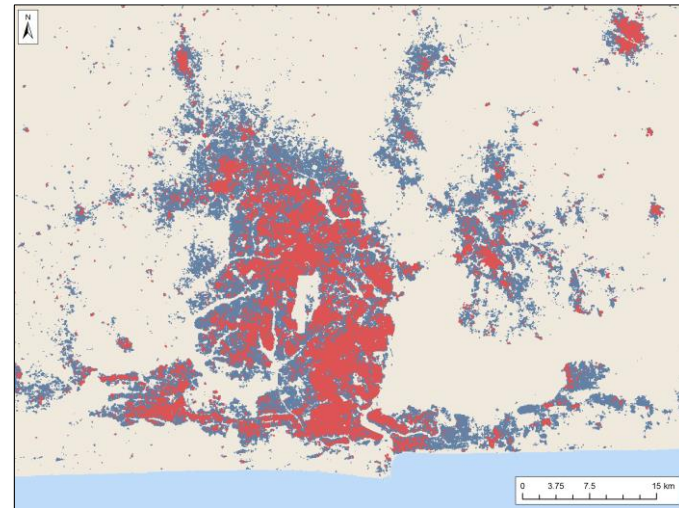
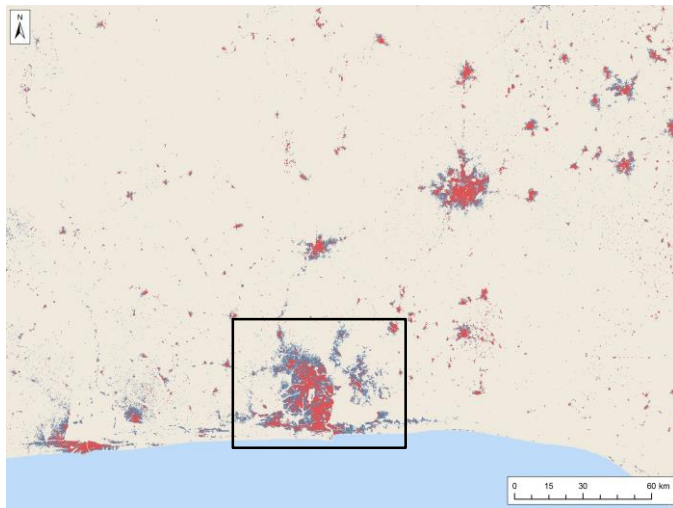
Benin



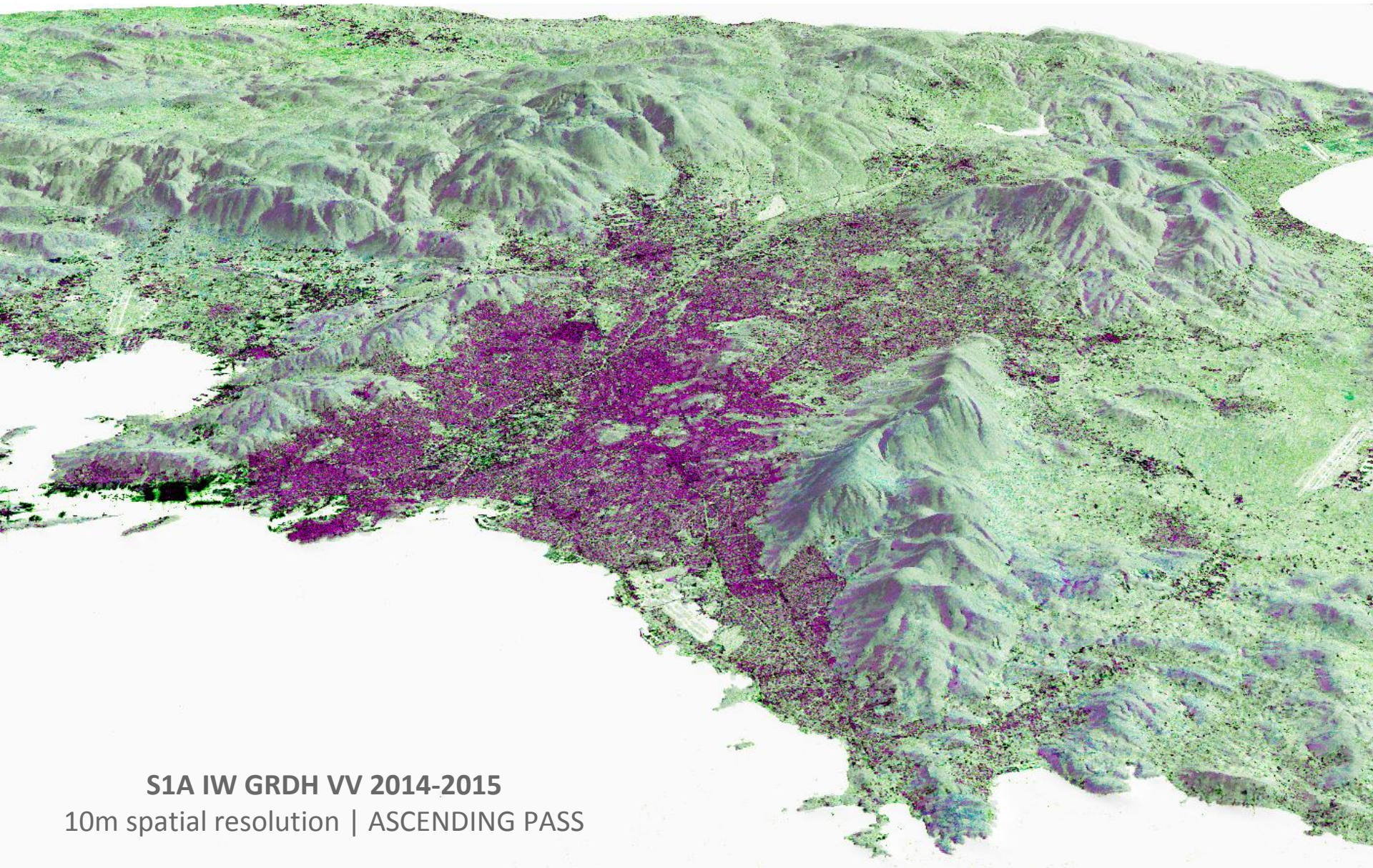
Nigeria



Lagos

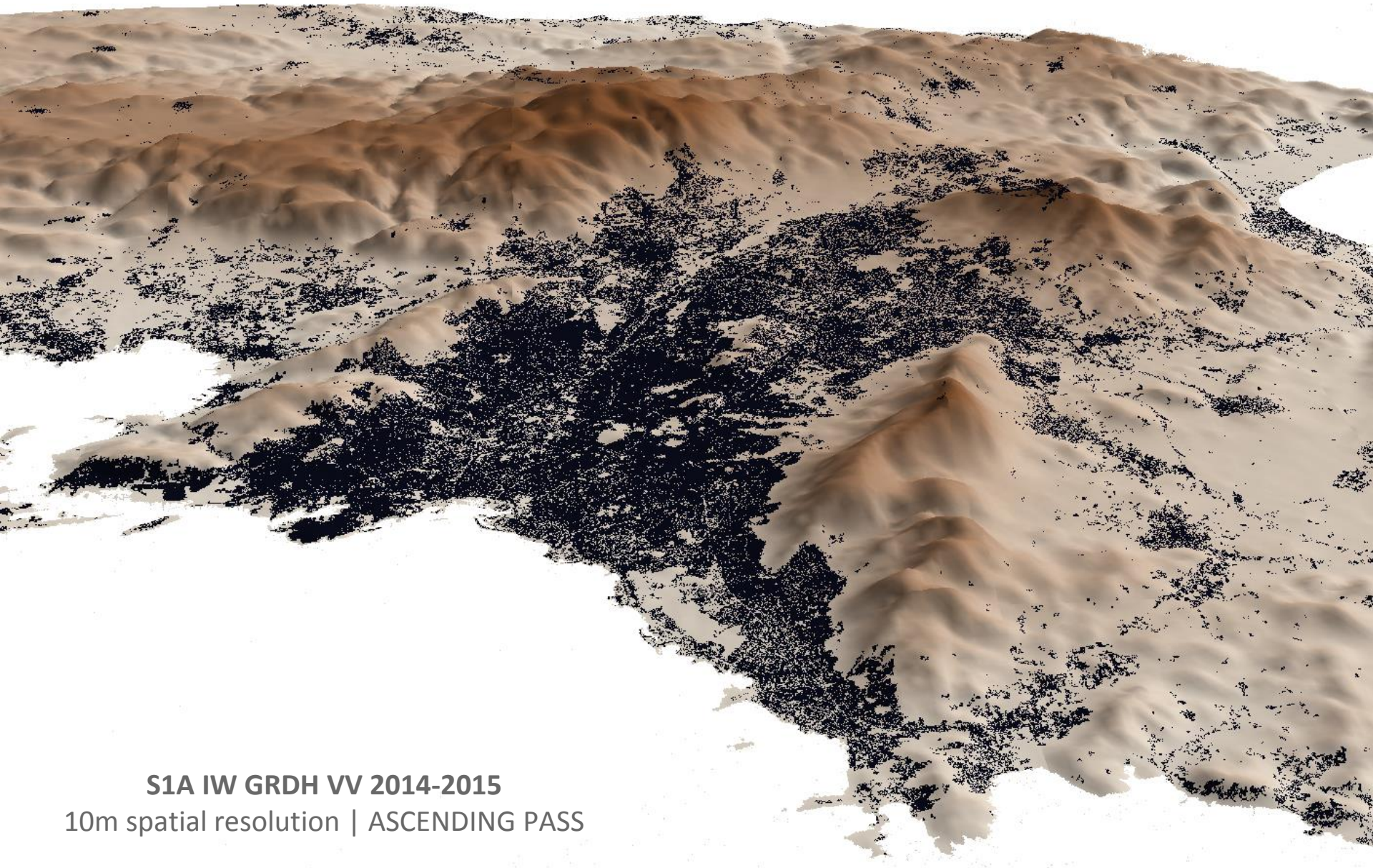


Sentinel-1 A



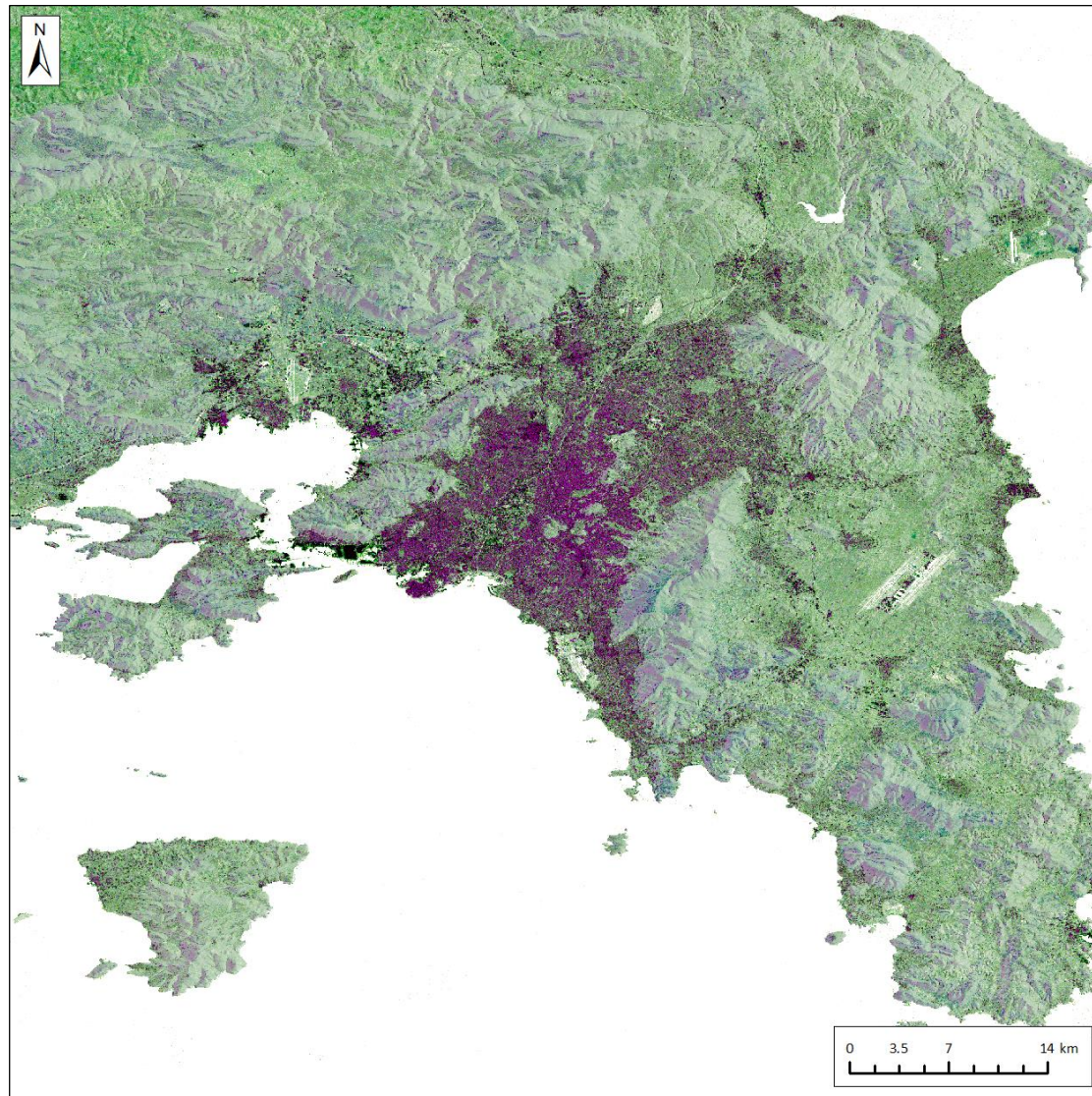
S1A IW GRDH VV 2014-2015
10m spatial resolution | ASCENDING PASS

Sentinel-1 A



S1A IW GRDH VV 2014-2015
10m spatial resolution | ASCENDING PASS

Sentinel-1 A



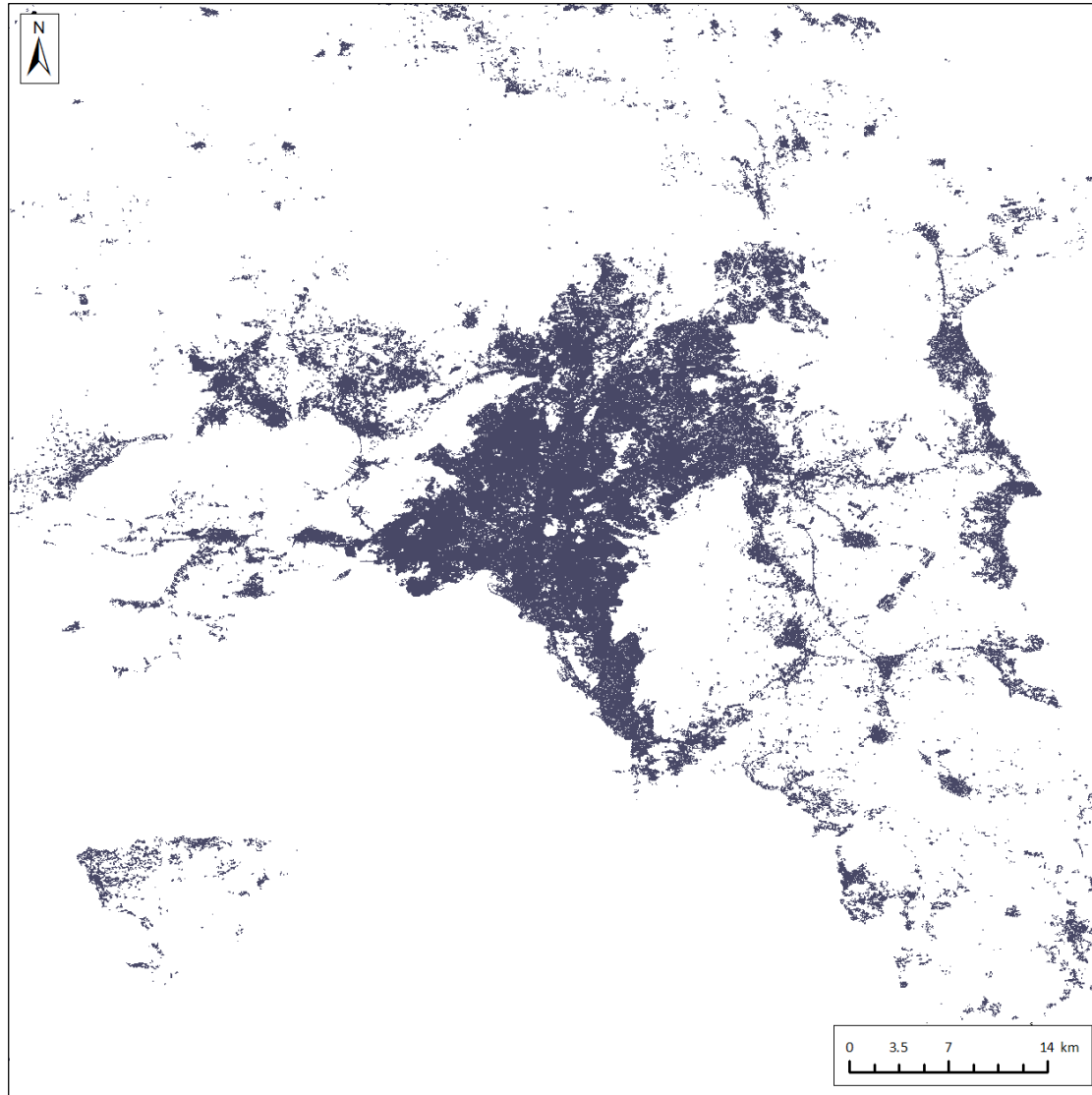
**S1A IW GRDH VV
2014-2015**
10m spatial resolution
48 scenes
ASCENDING PASS



Sentinel-1A

 Athens

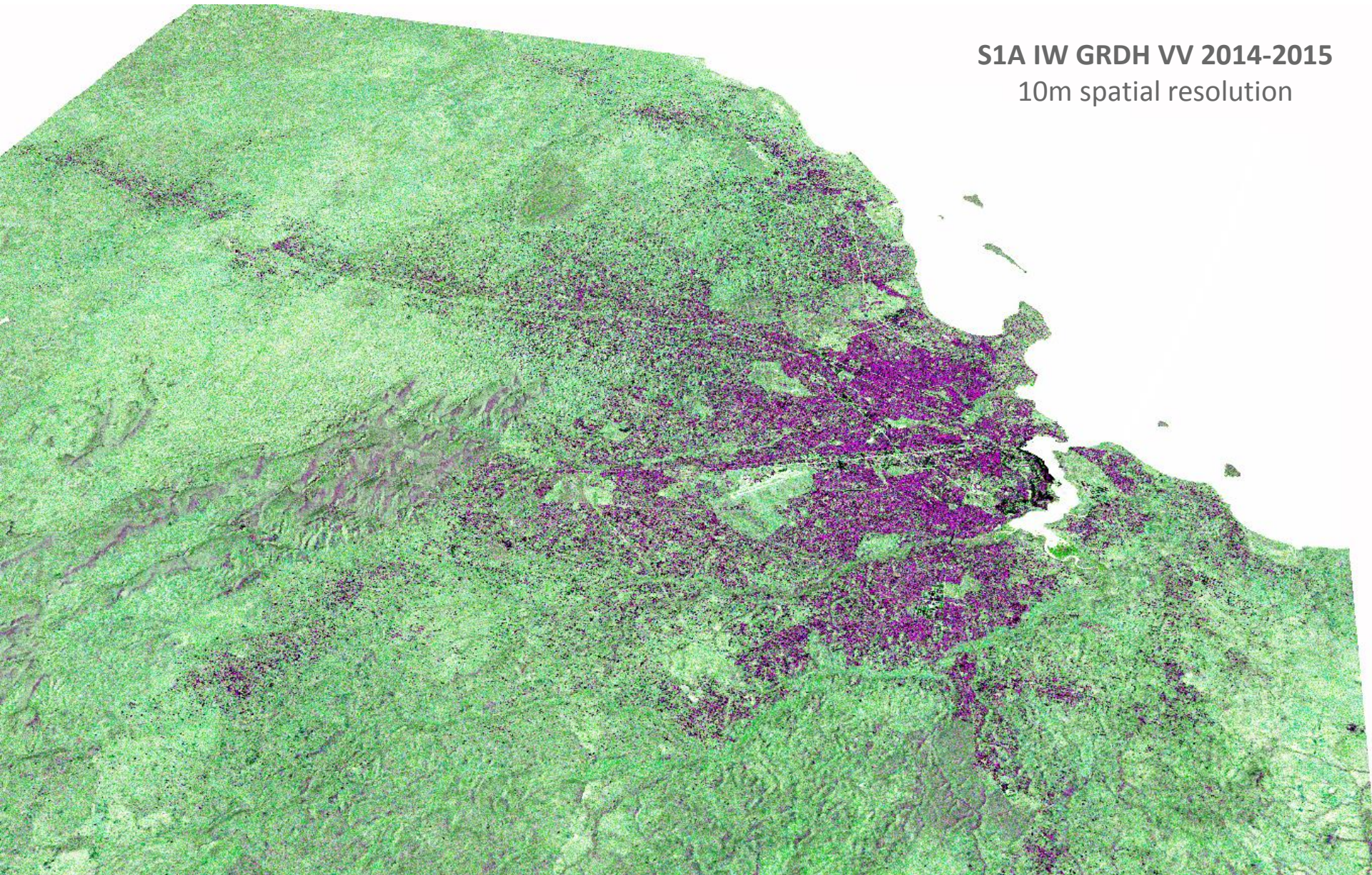
2014-2015



Sentinel-1 A

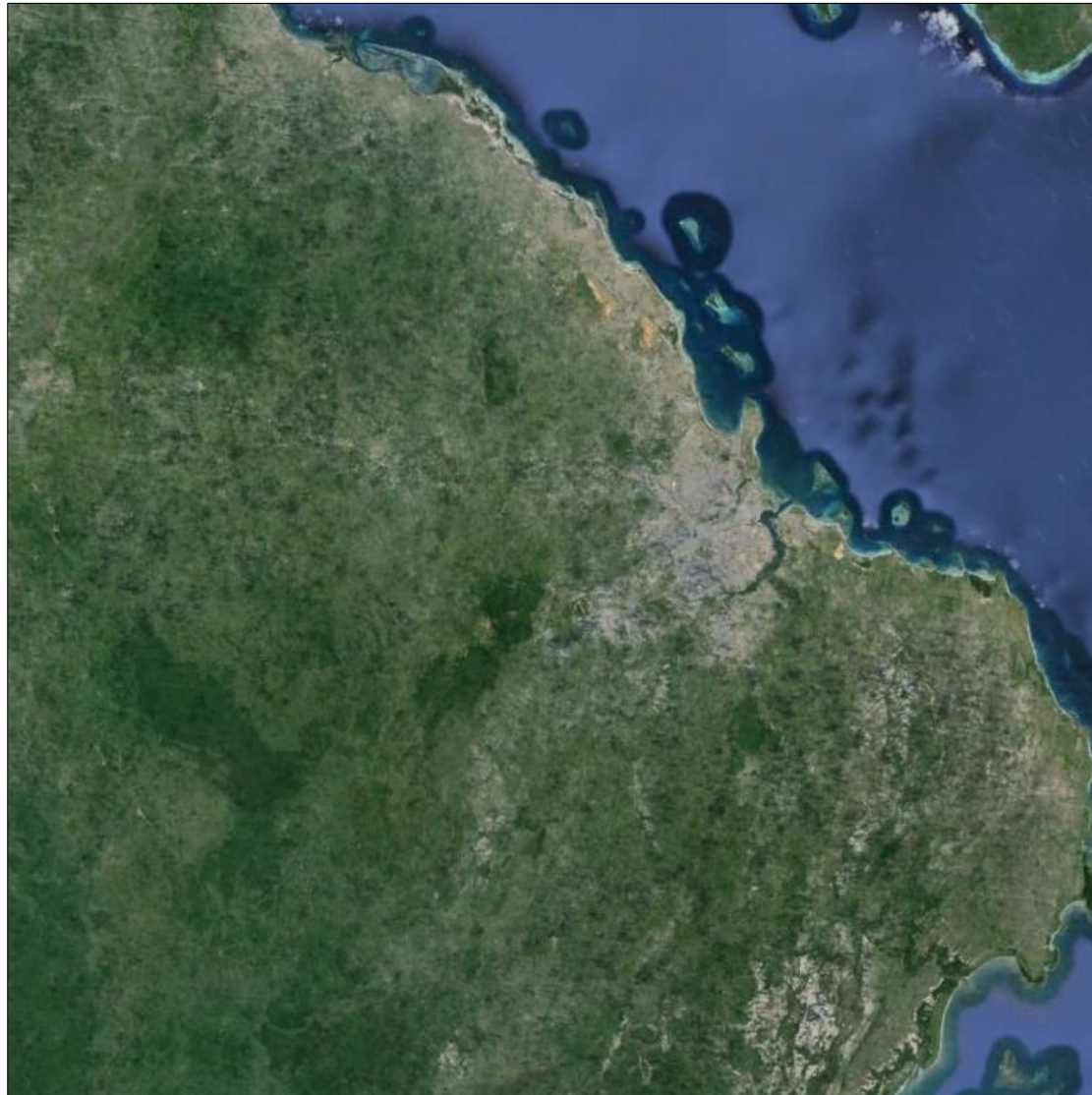
 Dar es Salaam

S1A IW GRDH VV 2014-2015
10m spatial resolution



First Results

 Dar es Salaam

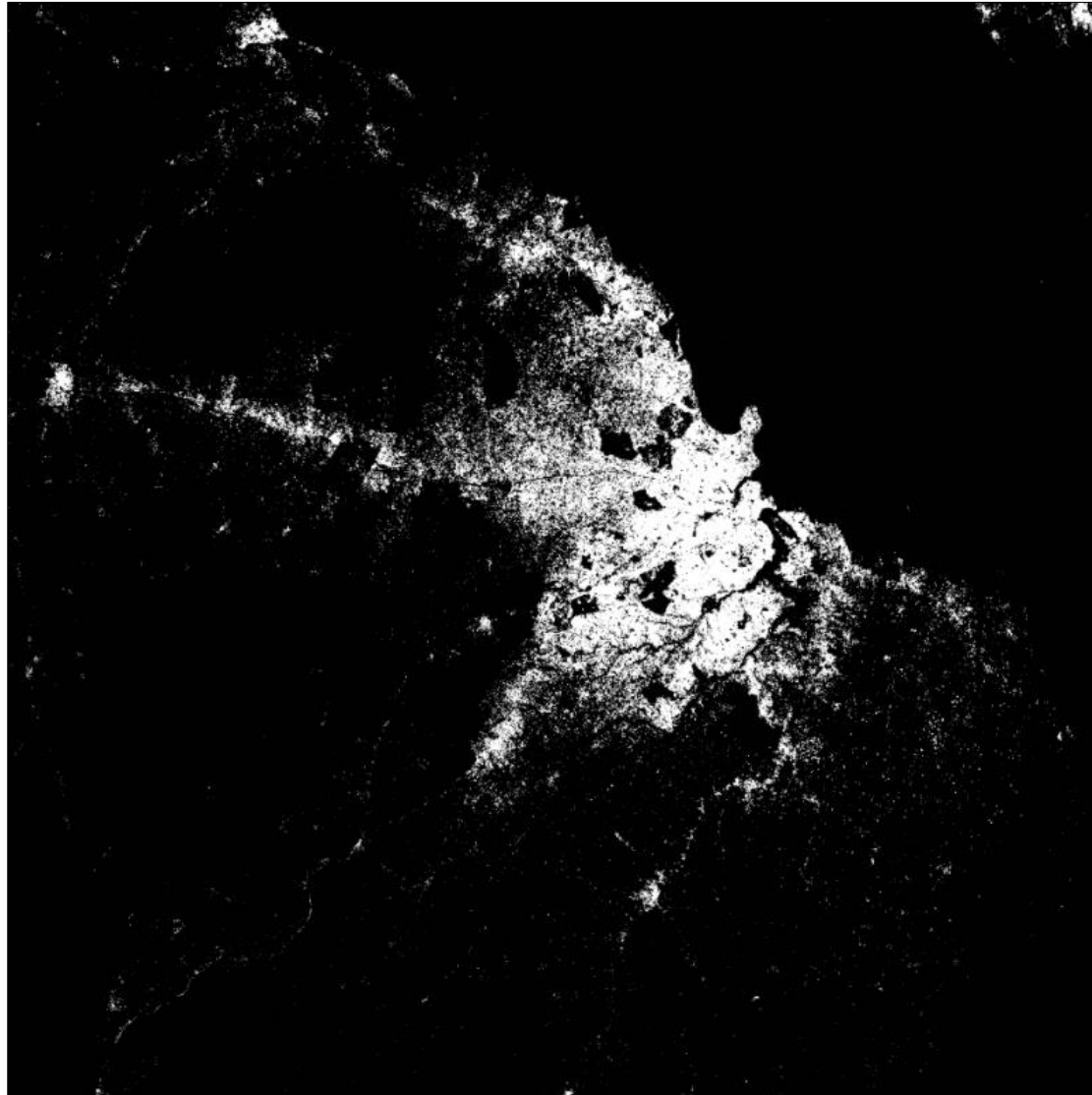


Google Earth



First Results

 Dar es Salaam



S1A IW GRDH VV
2014-2015

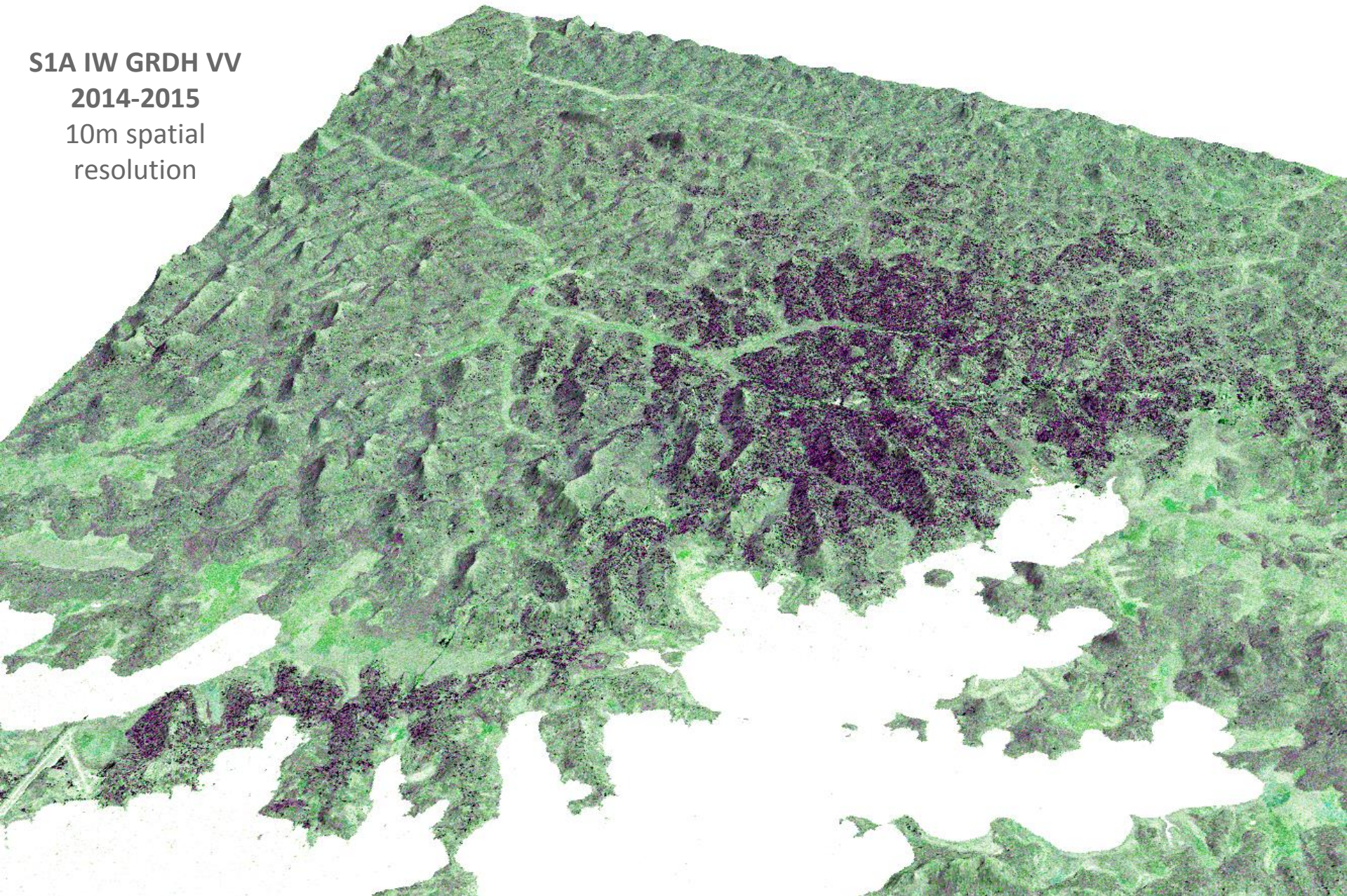
10m spatial resolution



Sentinel-1 A

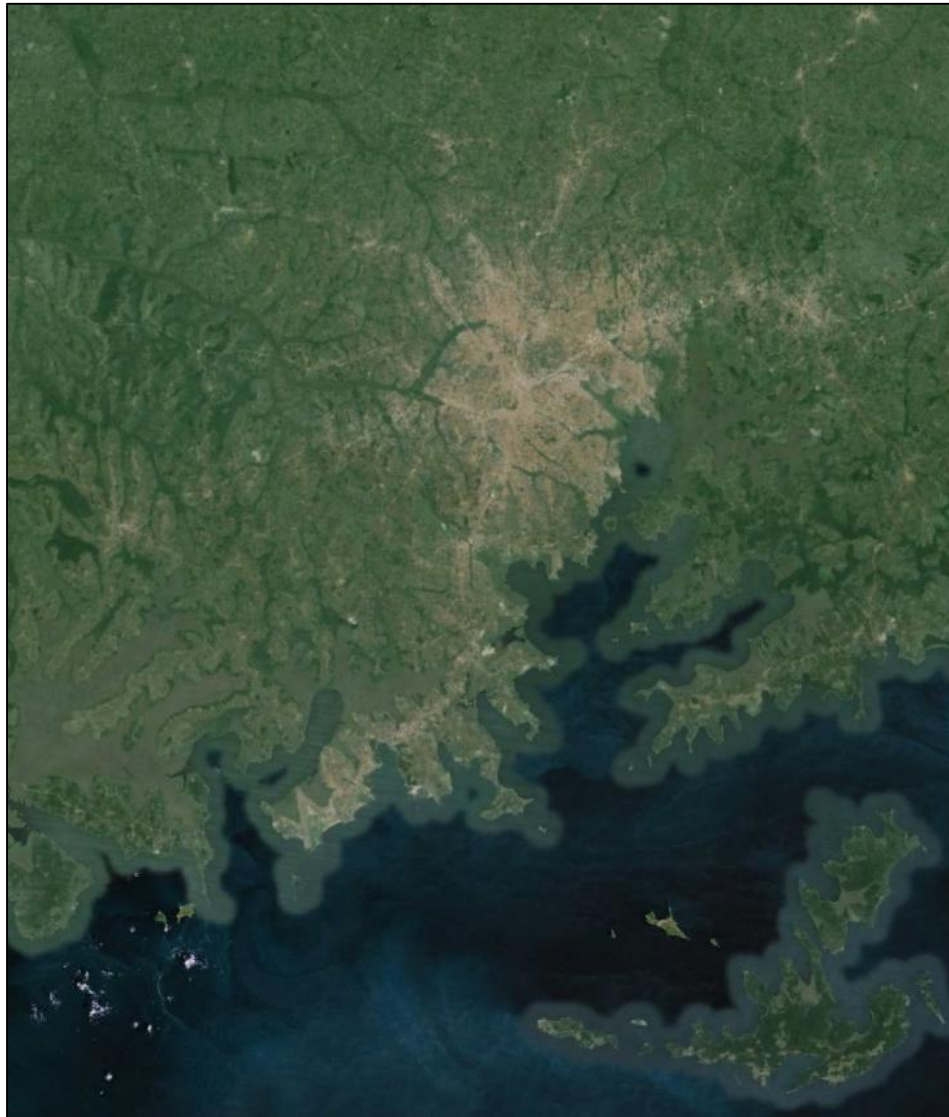


S1A IW GRDH VV
2014-2015
10m spatial
resolution



First Results

 Kampala

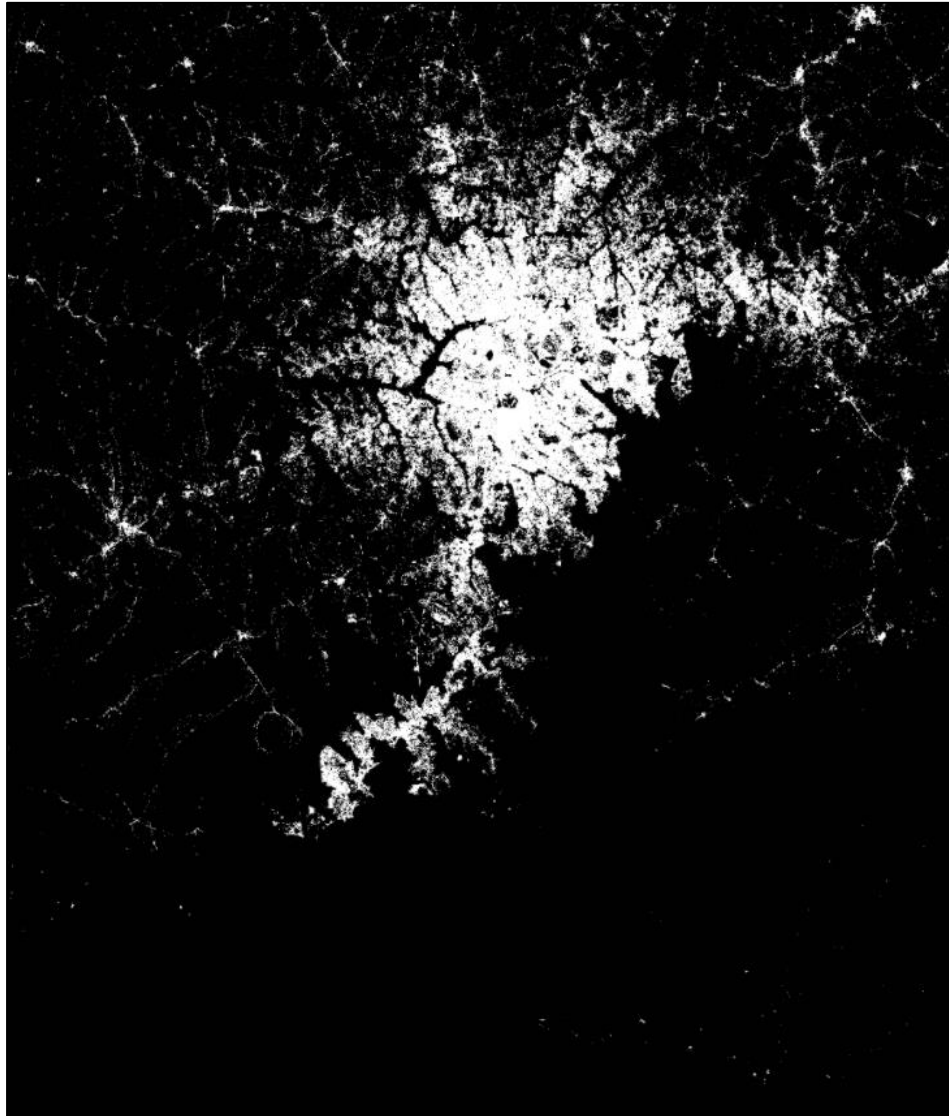


Google Earth



First Results

 Kampala

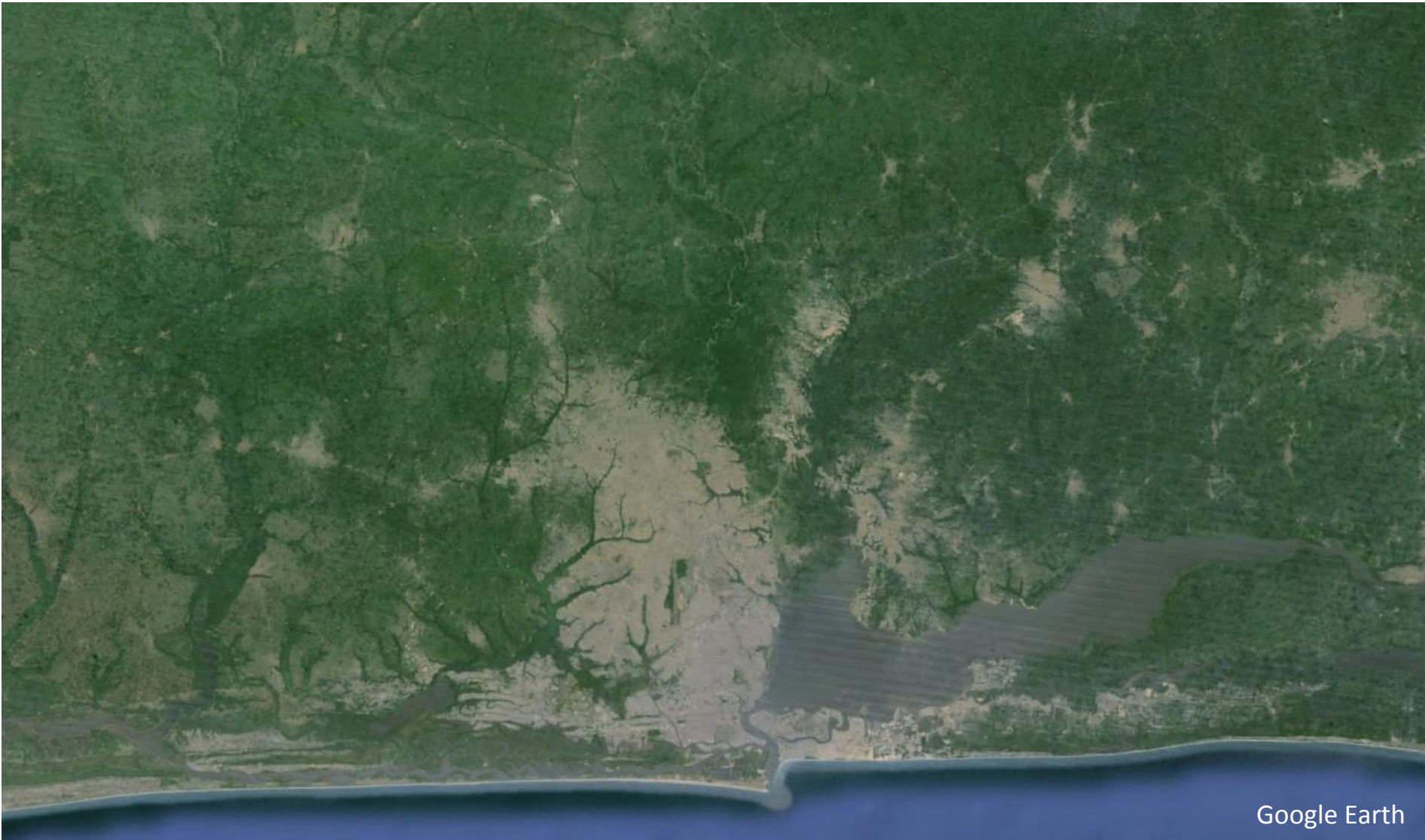


S1A IW GRDH VV
2014-2015
10m spatial resolution



Sentinel-1 A

 Lagos

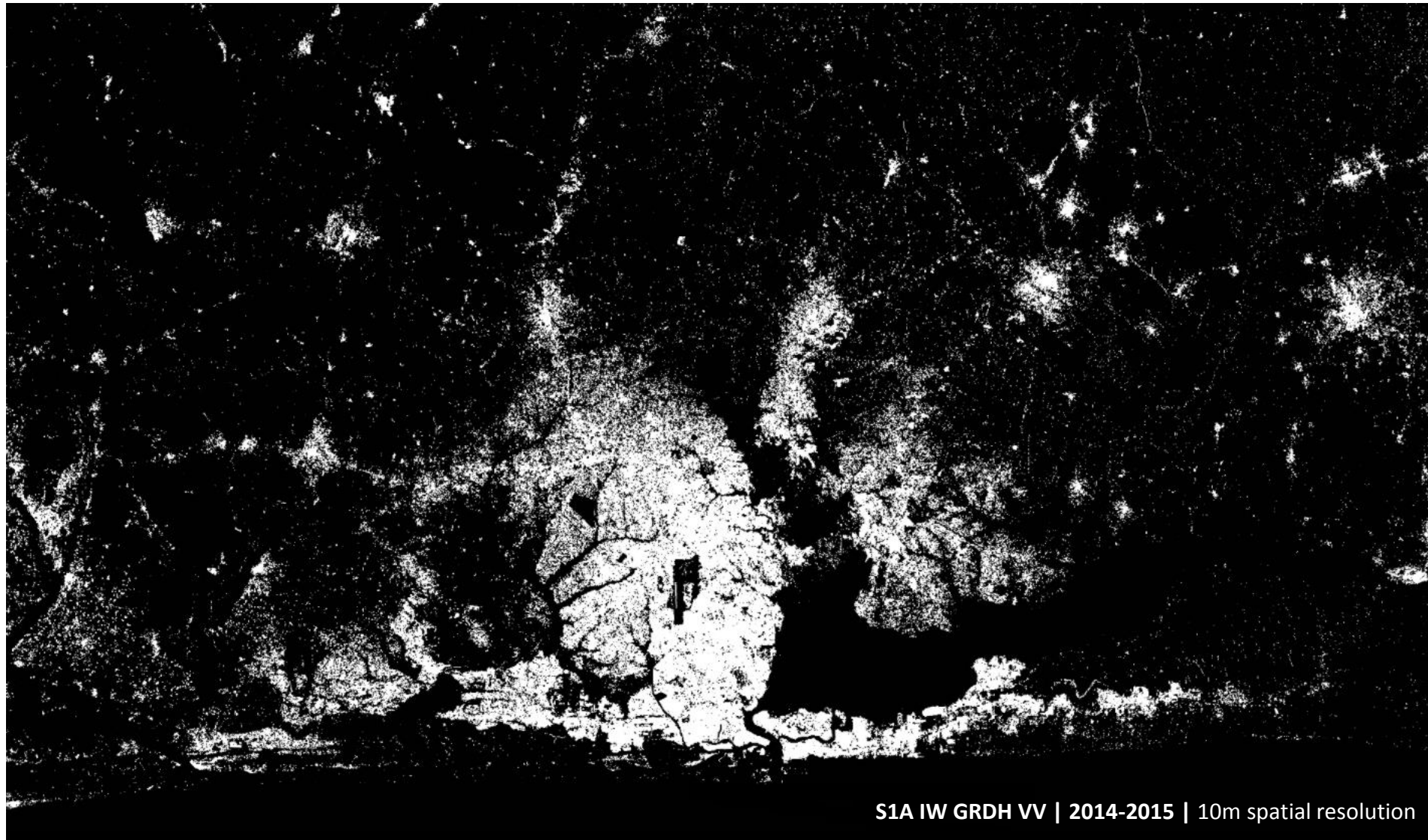


Google Earth



Sentinel-1 A

 Lagos



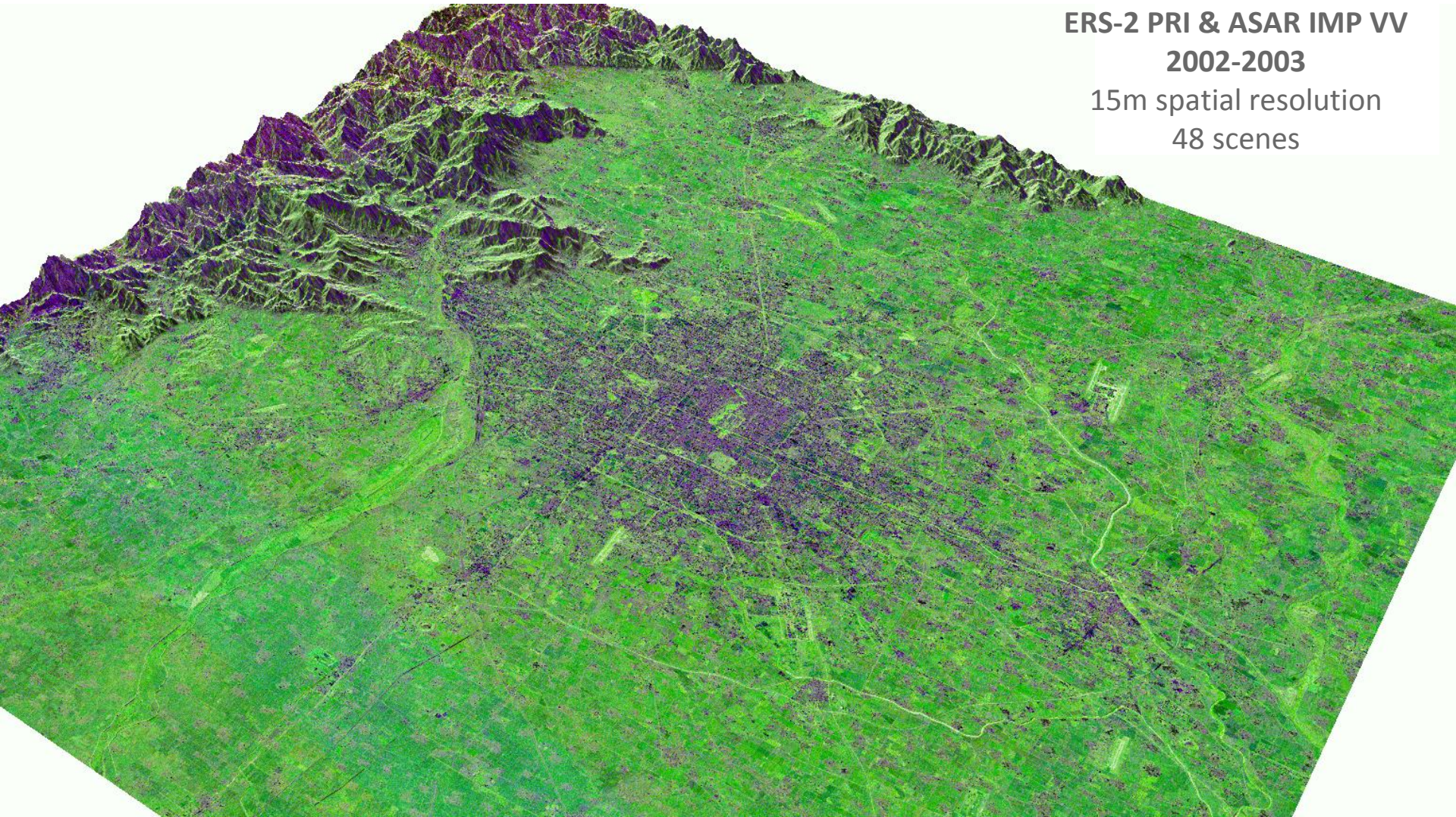
S1A IW GRDH VV | 2014-2015 | 10m spatial resolution



Urban Growth

 Beijing

ERS-2 PRI & ASAR IMP VV
2002-2003
15m spatial resolution
48 scenes



Urban Growth

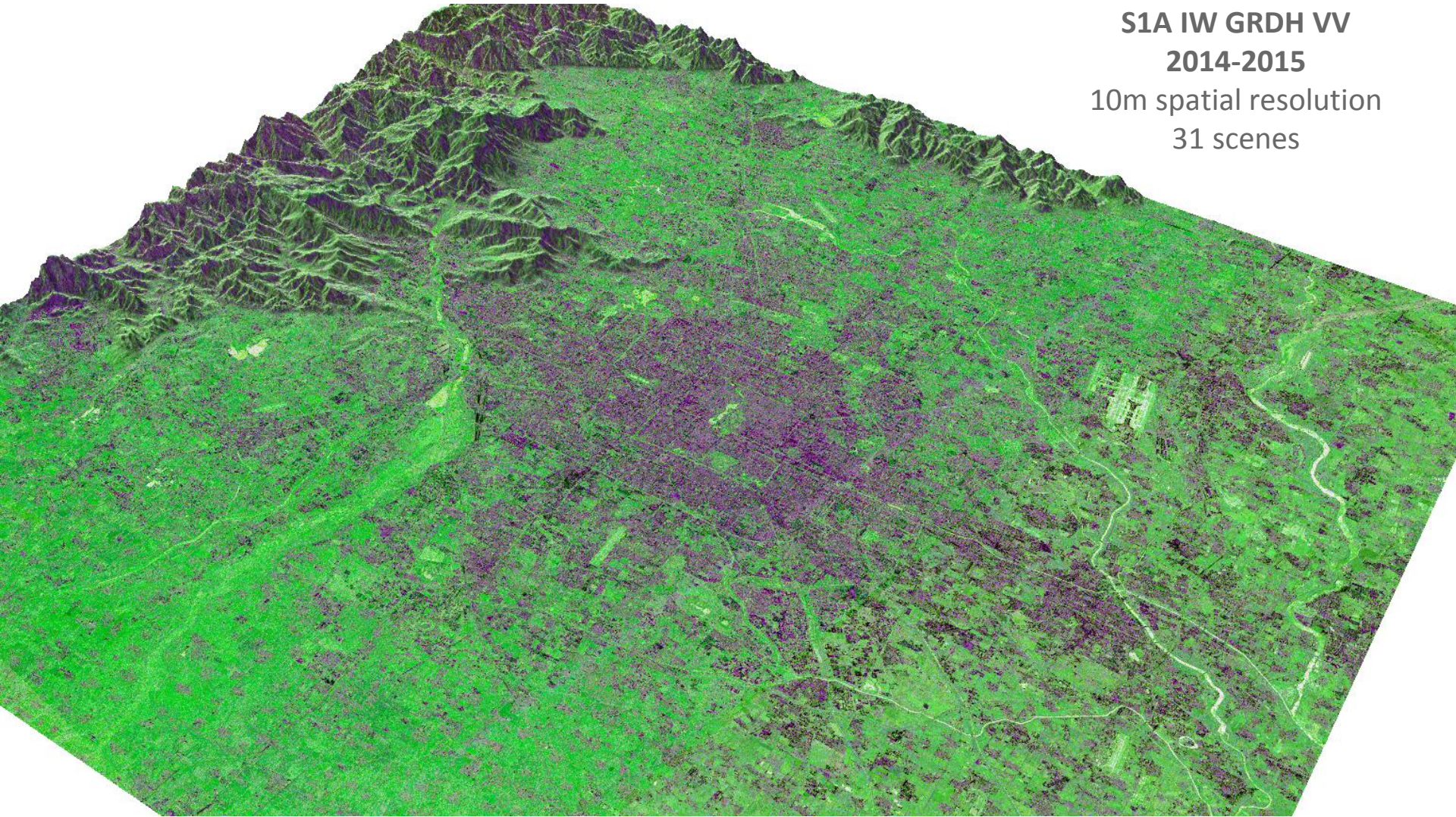
 Beijing

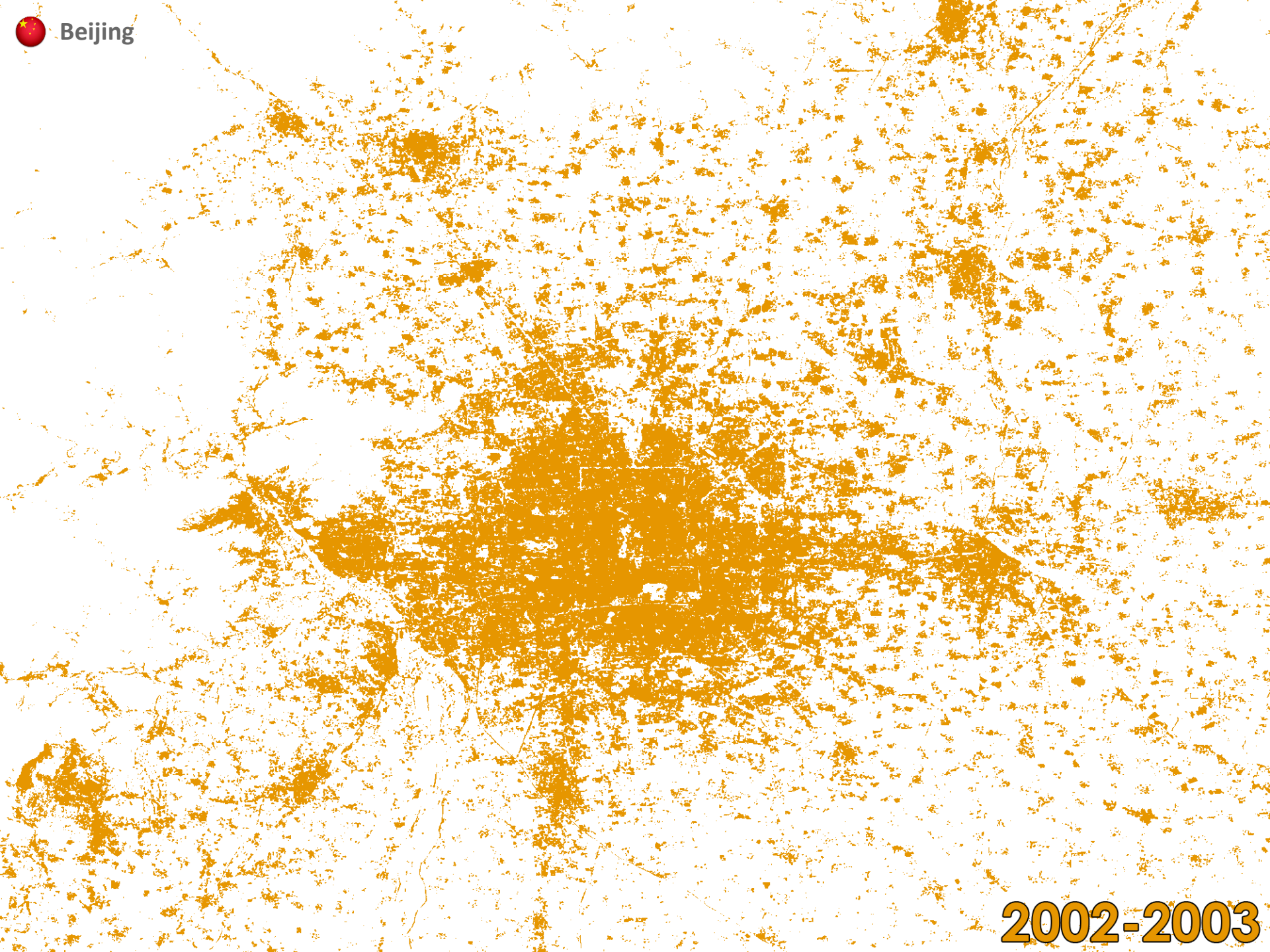
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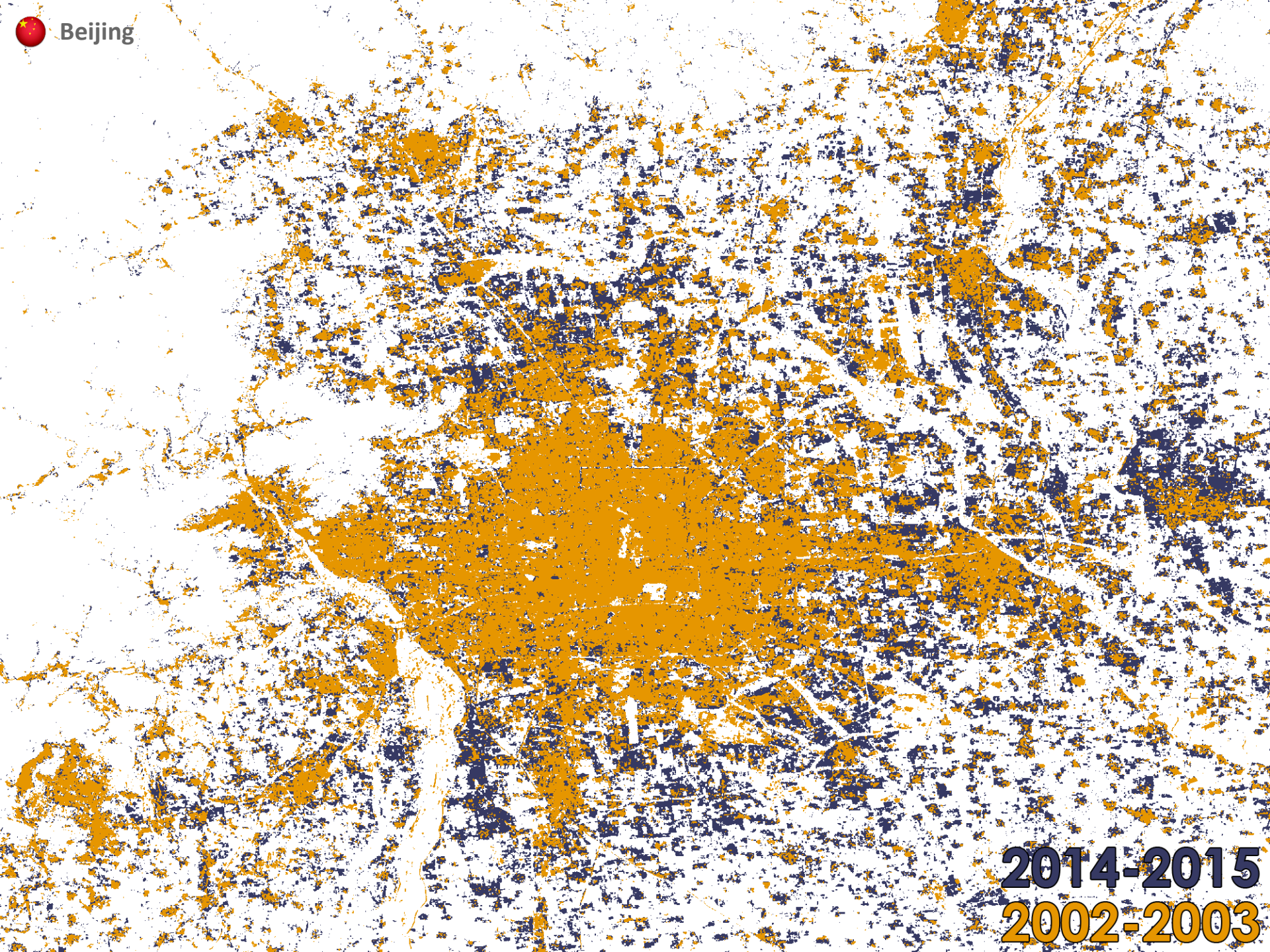
2014-2015

10m spatial resolution

31 scenes





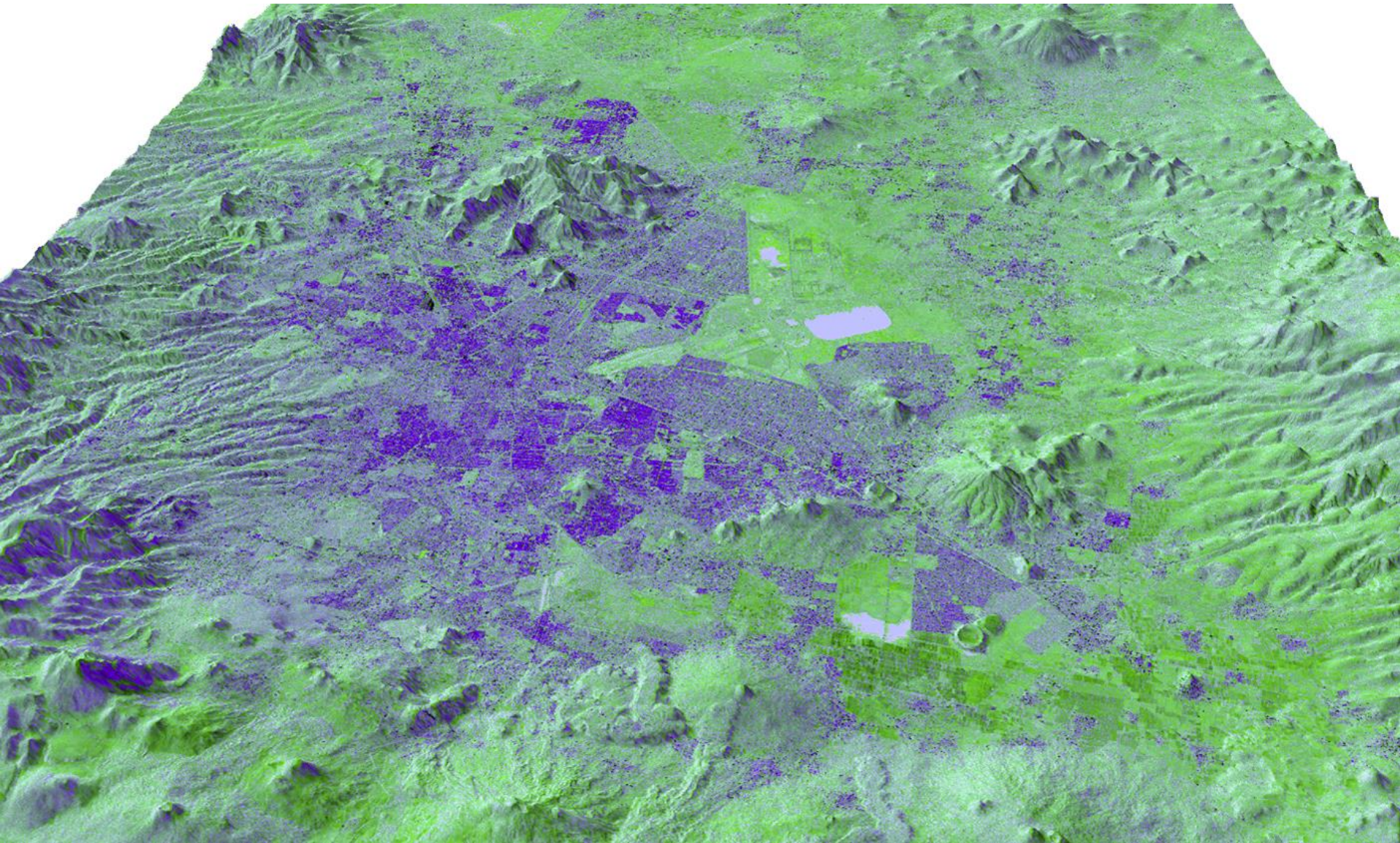


2014-2015
2002-2003

Urban Growth

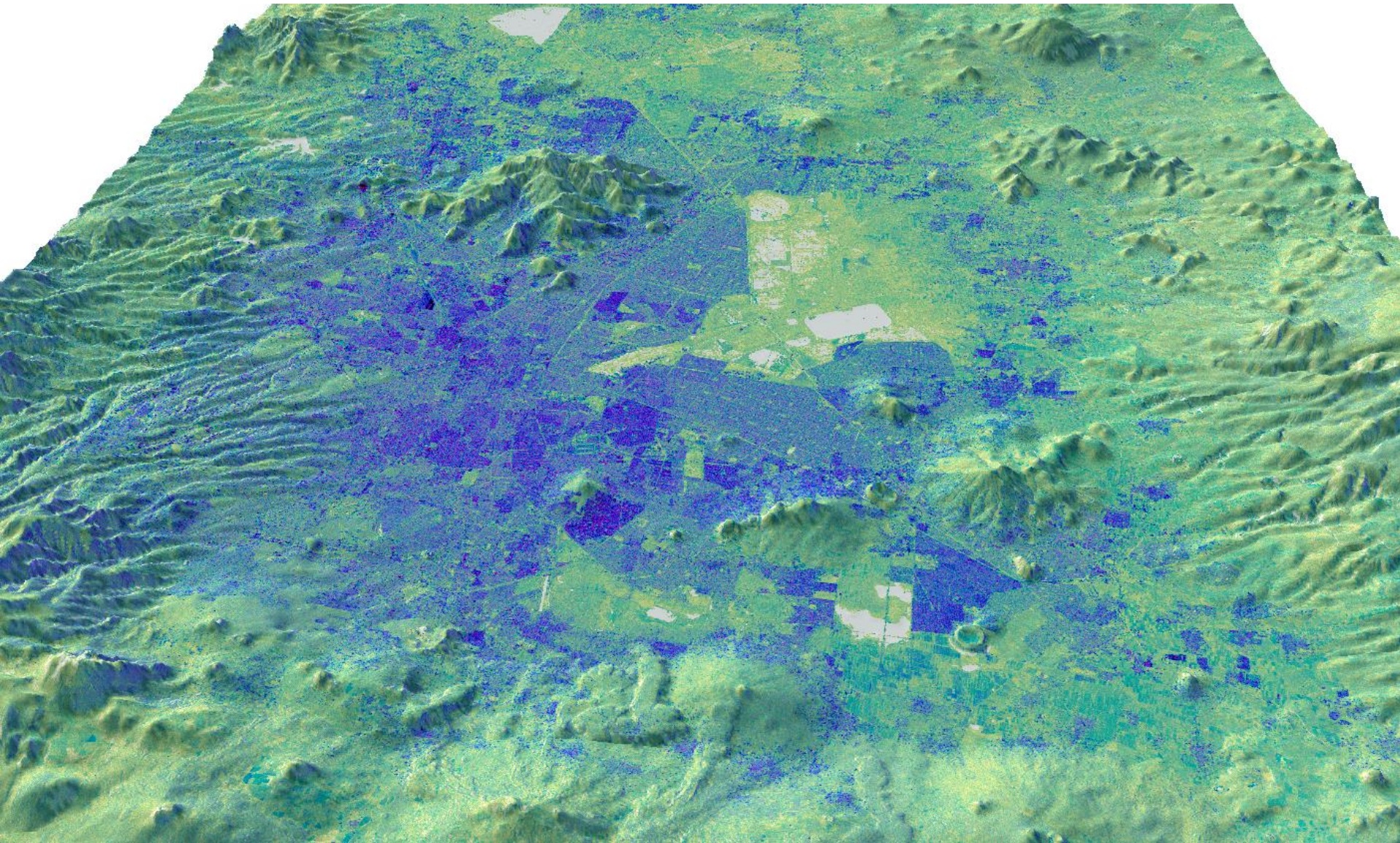
 Mexico City

ERS-2 PRI & ASAR IMP VV 2002-2003 | 15m spatial resolution



Urban Growth

S1A IW GRDH VV 2014-2015 | 10m spatial resolution





Mexico City

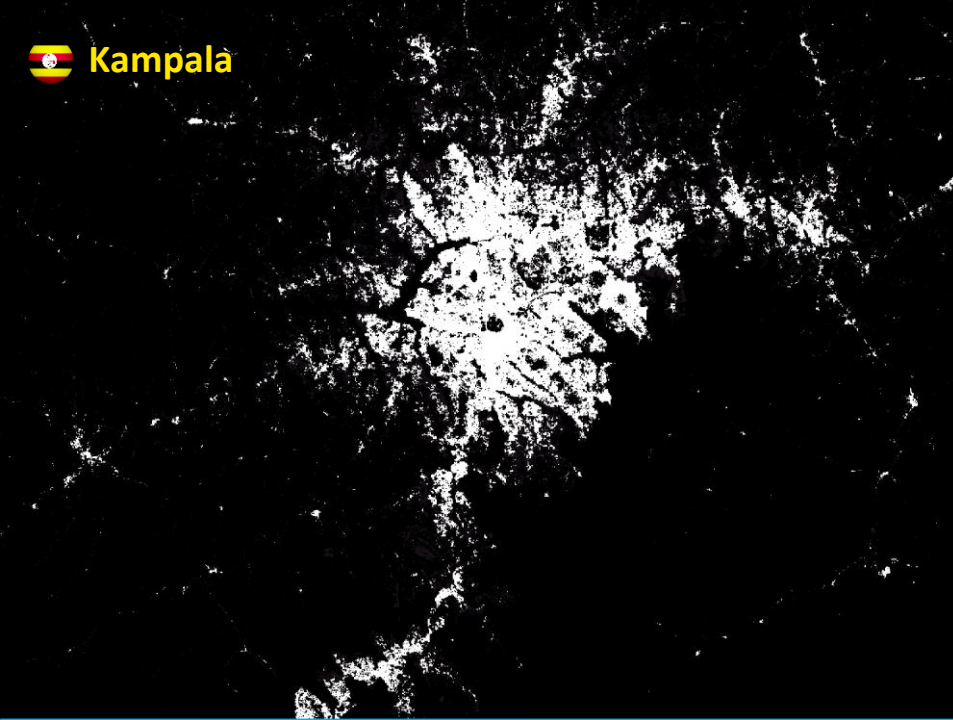
2002-2003



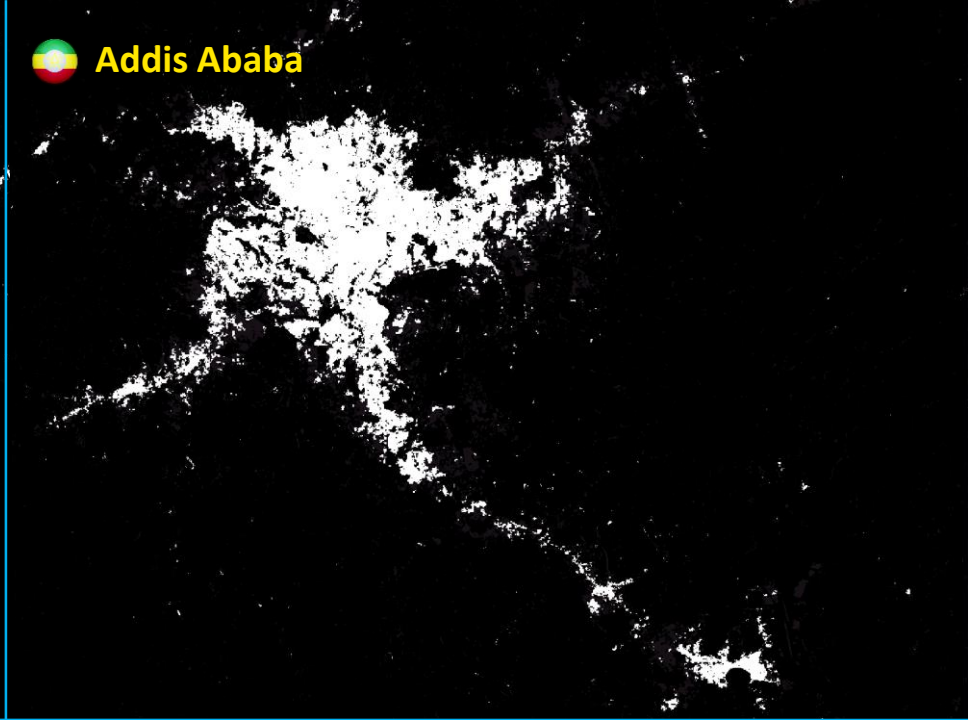
Mexico City

2014-2015
2002-2003

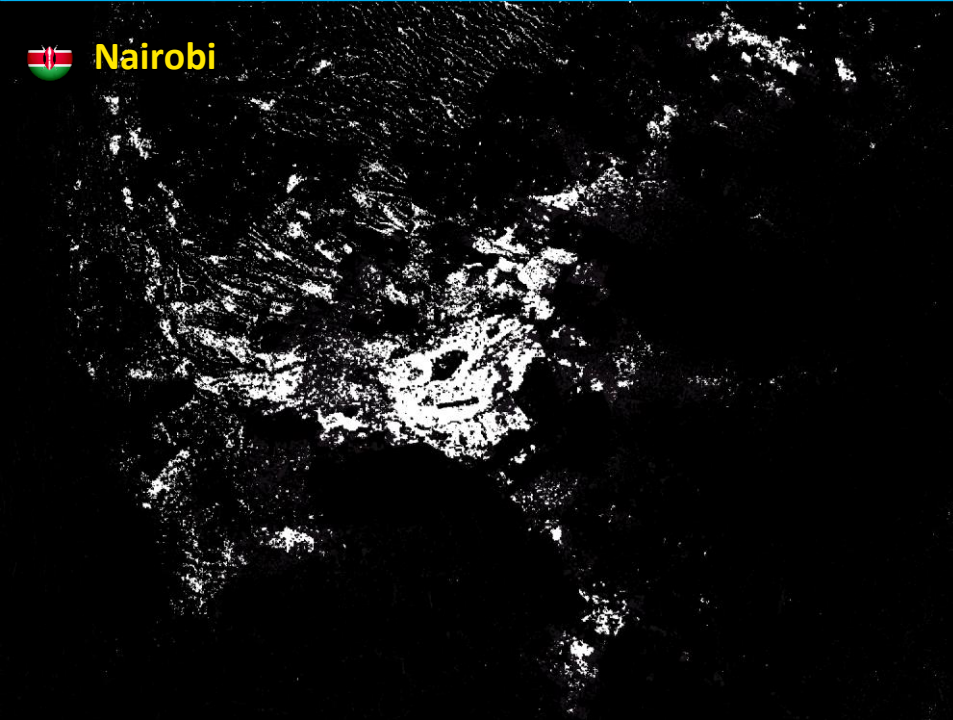
 **Kampala**



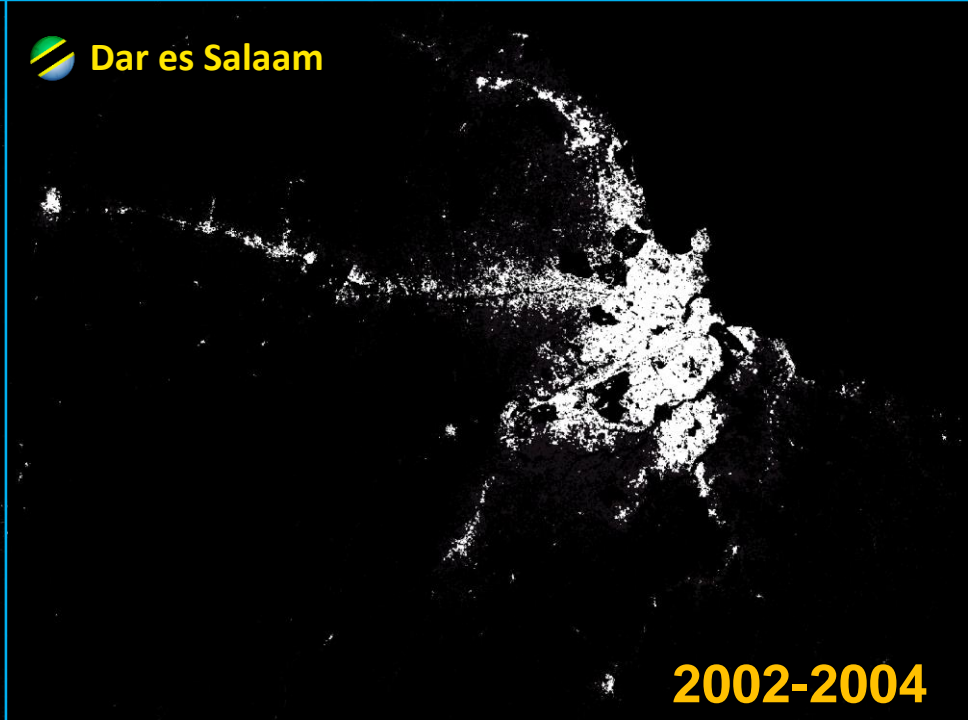
 **Addis Ababa**



 **Nairobi**

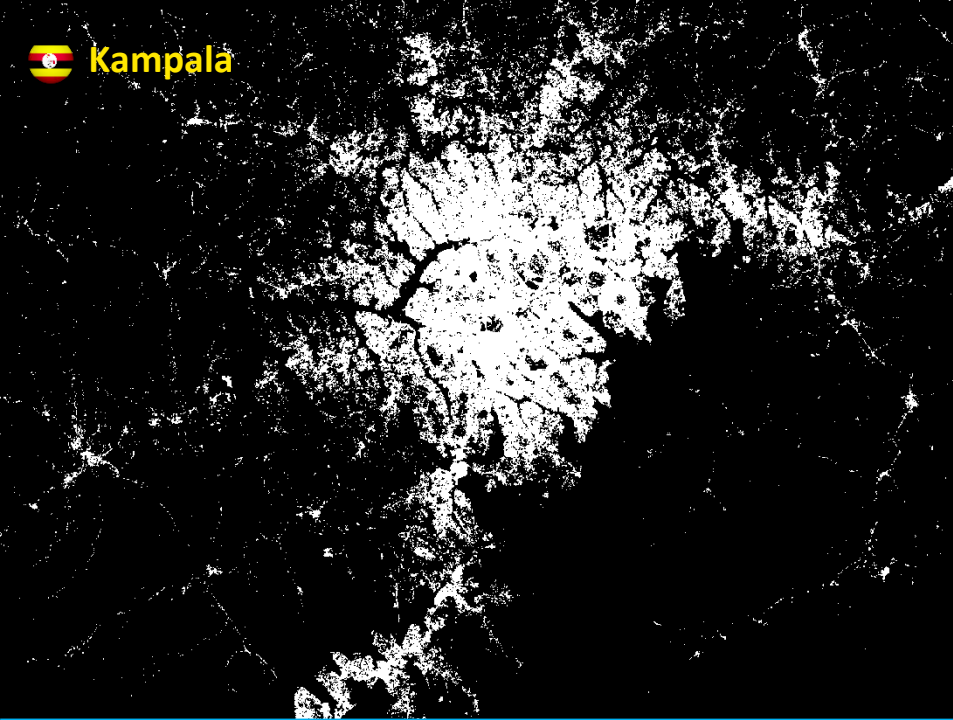


 **Dar es Salaam**

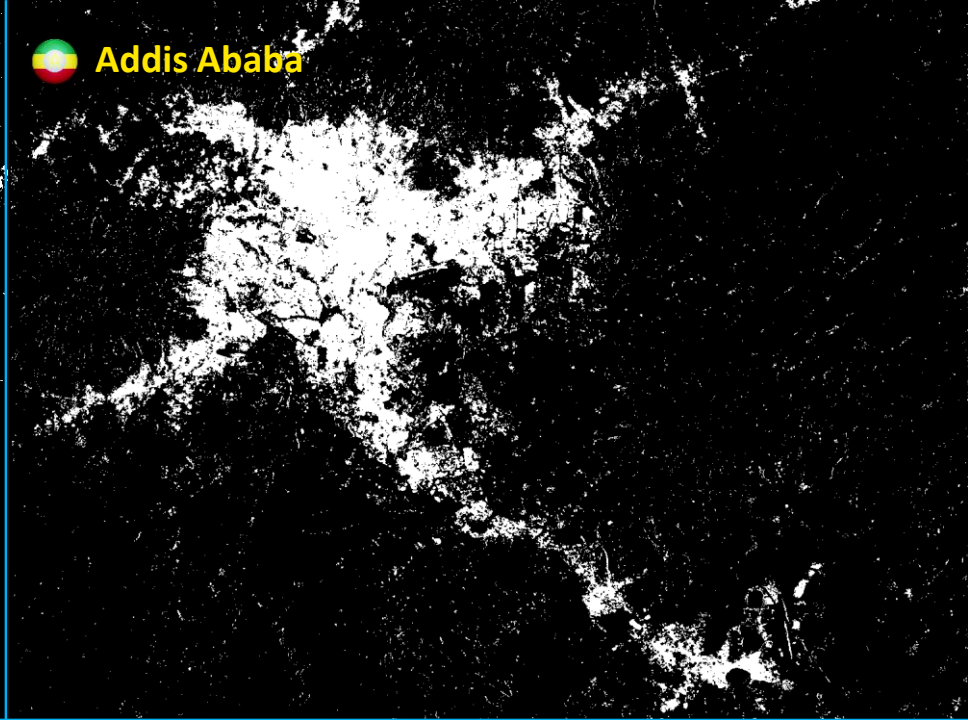


2002-2004

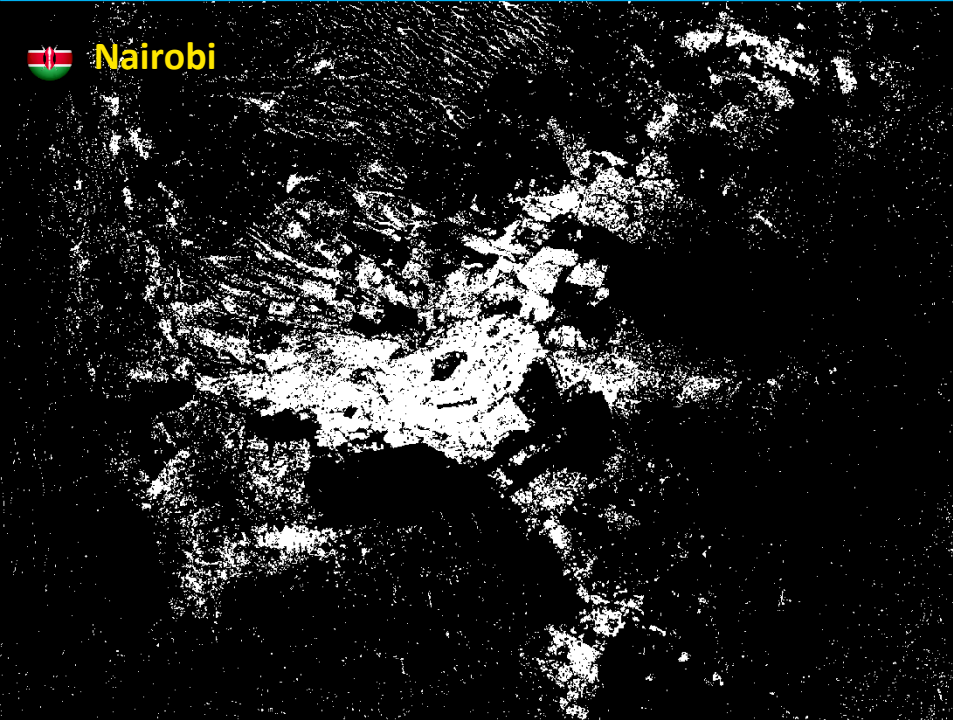
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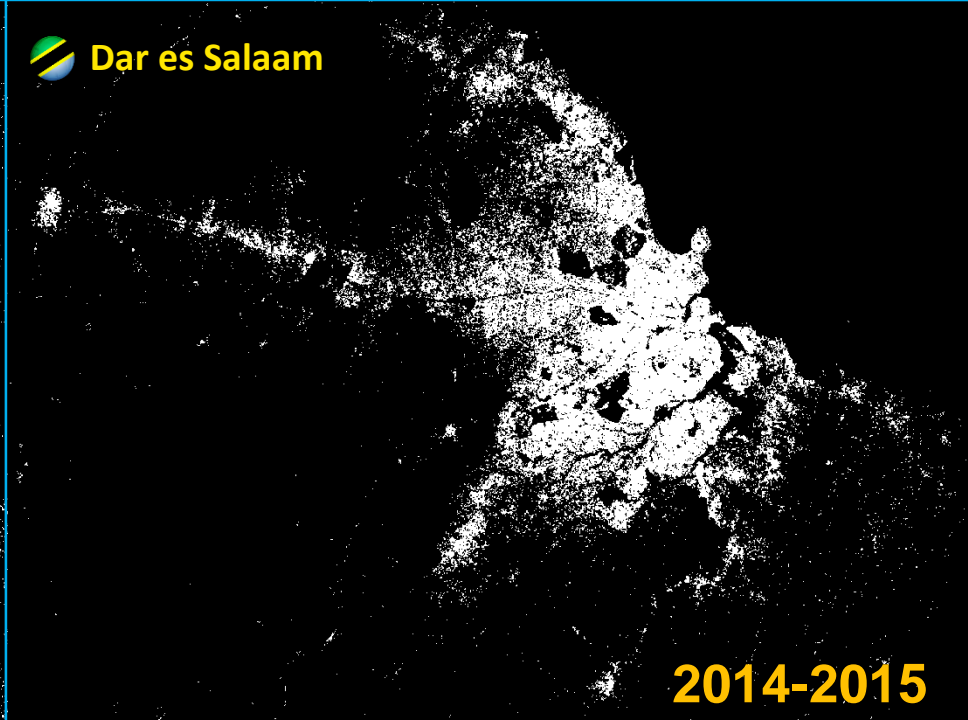
 **Addis Ababa**



 **Nairobi**



 **Dar es Salaam**



2014-2015

Outlook

- Implemented system proved **very promising for all considered type of data**;
- Great potential for **operational employment** with ASAR WSM data for the past and S1A data for the present at the **global scale**;
- Further **experimental trials** for further improving the methodology and **assessing the robustness**;
- **Validation** (yet ongoing) also in collaboration with local representatives for getting reference data.



thanks a lot for your attention



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